THE
VETERINARY JOURNAL

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THE PART PLAYED BY VETERINARY SCIENCE IN THE CONTROL OF DISEASES OF PIGS.

THE VETERINARY JOURNAL is a little unlucky in the fact that the Report of the Pig Industry Commission, although stated to be nearing completion, has not yet been issued; but perhaps this may be turned to good account in that this Special "Pig Diseases" Number may be of some value to them in drawing up their final conclusions, as it illustrates the value of the research work done by the veterinary profession in the control of the decimating epidemics which affect the pig equally with the other farm animals.

The members of the veterinary profession, individually and collectively, have for years been asking for the opportunity (and financial support) to demonstrate their value as controllers of animal epidemics and disease. It is only lately that the Government, through its selected representatives, the Agricultural Research Council, under the able guidance of Sir Merrik Burrell and the Veterinary Committee, have seriously recognised the fact (which other countries have for many years fully made use of) *that the proper person to control animal disease epidemics is the man who has been trained in this branch of science, viz., the duly qualified veterinary surgeon.*

The general public, and even our Parliamentary rulers, appear even in 1932 to be still ignorant of the fact that the veterinary graduate of to-day has been compelled, before being allowed to enter upon his studies in a Veterinary College, to matriculate in the same way (University or High School) as his brother in human medicine, and that at least five years for the diploma, or five and a-half for the University degree, must be spent at a Veterinary College before he can

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add after his name the mystic letters M.R.C.V.S., or B.Sc. (in Veterinary Science). In the past there has been no adequate Government support for the Colleges where such a severe training is voluntarily undertaken, and the folly of such lack of financial encouragement is that there is (and will be for at least another ten years) a shortage of veterinary surgeons, which is literally a peril to the Empire. The other countries of the world, including our Colonial possessions, have been more far-seeing than ourselves, and have built and endowed University Veterinary Schools, which are second to none in comparison with the medical faculties provided for the training of those who control epidemics and administer to the ailments of the human branch of medicine. The Universities of South Africa, Canada and Australia are striking illustrations of this. Even in Soviet Russia the well-equipped and well-built Veterinary Institutes make one feel ashamed of the neglect which is so obvious in England, and the London of which we are so proud to be citizens.

The Veterinary Colleges of Germany, France, Holland, Belgium, Denmark, Sweden, Norway, Switzerland, Austria, Czecho-Slovakia, and even Turkey, are all of University standard, as are also those in North and South America, and Japan.

Why is there this apathy in Great Britain ? The land which boasts so loudly, but somewhat hypocritically, of its genuine love for animals. We have the brains to do the necessary research into these animal disease problems, but the young graduate is usually compelled to earn his living as soon as his diploma is obtained ; *and the pay and promotion offered by research has, up to now, been of such a miserable nature that he has been compelled to enter the ranks of the general practitioner, where his own personal individual efforts can obtain full reward.*

The epidemics of pig diseases, for which at the present time there is a crying need of control, form only one illustration of past neglect ; and the need for scientific research into these is only equalled by the need for the farmer of research into the remedies awaiting discovery for such diseases as sterility, contagious abortion, Johne's disease, tuberculosis, and a host of others in cattle and the larger farm-stock animals. It is folly to merely slaughter and to keep paying out compensation *unless research into prevention is also considered. This side of the question can only be effectively attacked by subsidising scientific research ; and for diseases of the pig, as well as any other animal patients, the work can only be effectually carried out by the trained veterinarian.*

The great work which Sir Arnold Theiler has done for South Africa can also be done for Great Britain, and if only the Public and the Government will promise the financial support, the veterinary profession can quite effectually supply the necessary workers.

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General Articles

MODERN NUTRITION RESEARCH AND PIG-FEEDING PRACTICE.

By CHARLES CROWTHER, M.A., Ph.D.
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THE twentieth century, with barely one-third of its course run, has seen a remarkable advance in our knowledge of nutrition. At its opening, the current teaching was content to regard the values of foods or rations as adequately defined by their content of available energy (or gross digestible energy), and of digestible protein. On this basis two rations that were equal in energy supply and protein supply were to be regarded as of equal value, and the actual constituent foodstuffs from which they were compounded might consequently be regarded as of little or no significance except in so far as they might influence factors such as palatability, or the quality of products such as milk, body fat, or butter fat manufactured by the animal from its food. Mineral requirements were regarded as so small that deficiency was hardly likely to arise in farm practice, except perhaps as regards the supply of calcium and phosphorus where rapid bone formation or high milk yields were in question. Practical experience that did not harmonise with these views was largely disregarded, not as being unimportant, but as either inexplicable, or based upon faulty deductions. At this period, therefore, the attention of nutrition investigators was largely directed to the study of energy relationships and the nature of the proteins, and in both fields remarkable advances were well under way before the close of the last century.

In the matter of energy supply, the first advance came in the solution of many discrepancies between theory and practice through the successful analysis of available energy into that part of it which is liberated in the animal as heat either directly or after being utilised for the internal work of the body and degraded thereby to the form of heat (thermal energy), and the balance which is available for productive purposes (dynamic energy or nett digestible energy). Here was provided at once the explanation why, for example, quantities of hay and maize meal that contain equal amounts of available energy show such different productive effects, since the former, being a coarse fibrous material, demands for its mastication and digestion more energy than the latter, and consequently leaves at the disposal of the animal a smaller surplus of " nett " energy for production purposes. For the development of this conception in its application to the feeding of farm animals we are indebted above all to the work of Kellner, in Germany, and Armsby, in America, on which are based, so far as energy values are concerned, the modern methods of scientific control of rationing.

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In the domain of protein research also the way to a more precise understanding of their functions in nutrition had been opened up by the brilliant work of Emil Fischer and others, which had demonstrated that these hitherto mysterious and baffling nitrogenous substances were definite chemical entities of a very complex nature, built up from a variety of " structural units " belonging mostly to the classes of amides and amino-acids. Subsequent research has demonstrated that individual proteins differ widely with respect to the kinds and proportions of these " structural units " present in them, and, furthermore, that in the animal the proteins are assimilated in the form of these " units," into which they are resolved by the proteolytic enzymes of the digestive juices. In other words, in considering food supplies the quality of their protein, as determined by their " make-up " of these amides, amino-acids, etc., must needs now be taken into account, as well as the quantity of proteins present. To the practical bearings of this matter we shall return later.

Within the first decade of this century came the momentous discovery of the vitamins, and in the second decade the revival of interest in the functions and practical significance of the mineral ingredients in the dietary. Out of these two developments has arisen the study of deficiency diseases and less acute phenomena of malnutrition, bearing closely upon the health and constitutional vigour of animals, which now so largely dominates the field of nutrition research. Cutting across all these lines of study of individual factors is the newer work on the correlations between different factors, and their interdependence on each other, of which the simplest and perhaps most familiar is the case of the interaction of the supplies of calcium and phosphorus, or, more broadly, of the basic and acidic ingredients, in the diet. " Balance " in the proportions of individual factors present is now being revealed as a consideration that must be taken into account alongside the actual amounts of each factor supplied in drawing up the ideal dietary.

The intensive concentration in recent years upon the newer developments, often loosely described as the " new science " of nutrition, has tended to produce, especially in the lay mind, a distorted conception of nutrition as being primarily a matter of supply of vitamins, either directly or through irradiation, and of minerals. This has led to the widespread folly of the indiscriminate addition of vitamin and mineral preparations to all kinds of diets, regardless of whether such additions will remedy an existing deficiency or imperfection of " balance " in the diets—the only conditions under which benefit from the additions can be expected. This practice is the more to be deprecated through the knowledge that excess in the supplies of certain factors that may be brought about by such additions may be actually detrimental in their effects. This certainly applies, for example, in the case of the supply of lime, an excess of which has been found in experiments with poultry to produce a form of lameness. The simple fact, of course, is that the newer knowledge of nutrition has in no sense replaced the old science, but has merely amplified it and made its application to practice more

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precise and efficient. To say that " feeding by calories " is out of date would be just as absurd as to say that improvements in the motor car engine have eliminated the necessity for a supply of petrol in the tank.

The effects produced by a ration must obviously be attributed to the whole complex of factors embodied in it. If a ration be imperfect the effects of adding different materials to it will be determined by the extent to which they remedy its deficiencies or improve its " balance." We can predict, for example, that the addition of linseed cake to a maize diet will be less successful than the addition of an equal amount of protein in the form of soya meal, because certain " amide " deficiencies in the make-up of the proteins of maize are remedied more effectively by the soya proteins than by the linseed proteins, and the protein " quality " of the whole ration is thereby made better in the former than in the latter case. To borrow a word from the vocabulary of the breeder, the soya proteins " nick " better with the maize proteins than do those of linseed. One would not be warranted, however, in drawing from this individual comparison the general conclusion that soya meal is a better food than linseed cake, since the reverse would probably frequently be found to be the case if the maize were replaced by other foods or mixtures of foods whose proteins " nick " better with those of linseed. The same general considerations must obviously apply also in the case of the use of vitamin and mineral supplements. If they remedy a deficiency in the ration they will be effective ; if there is no deficiency they will be either ineffective or possibly even harmful.

Some of these points arise directly in practical pig-feeding, and may be illustrated by data from some of the feeding experiments carried out at the Harper Adams College Pig-Feeding Experimental Station.* The basis of all pig-feeding rations in common use consists of cereal meals. For the young growing pig such meals are deficient with regard to both quantity and quality of their proteins supply of certain mineral ingredients, notably lime and salt, and possibly also of vitamins A and D. These deficiencies alone are sufficient to explain the familiar observation that young pigs will only grow slowly on a plain cereal diet, and are prone to develop lameness or even rickets. This is borne out by the great improvement in the rate of growth and general health of the pigs that is effected when milk (in the form of whole milk, skim milk, or buttermilk) can be fed along with the cereals, since the milk enriches the diet not only with proteins of the best " quality," but also with the requisite minerals and vitamins. If milk is not available at an economic price, then obviously some milk substitute must be found to mix with the cereals if the capacity for rapid growth of the pigs is to be fully utilised. This milk substitute may be either a single food containing the necessary proteins, minerals and vitamins, or a mixture of foods that between them provide these supplies.

At the Harper Adams Station the pigs are housed in well-lighted sties facing south, east, or west, and permitting of free ventilation ; the pigs also go out

* *Pig-Feeding Report, No.* 1, Harper Adams Agricultural College, Newport, Salop, price 1*s*.

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daily into small exercise yards, and are given small quantities of fresh green-stuff. Under these conditions it is found that vitamin supply ceases to be a factor of practical importance in the selection of the milk substitute, and attention can be concentrated on the supply of proteins and minerals.

So far as protein supply is concerned, it has long been known that foods of animal origin rich in protein, like fish meal and meat meal, formed very effective milk substitutes, giving results almost equal to those obtainable with milk. This is only to be expected, since the protein of animal tissue must obviously contain all the " amides " required for its building-up in the body, and, moreover, in suitable proportions ; in short, we may surely expect that " meat " in the food will be an efficient raw material for the production of " meat " in the body. The erroneous conclusion, however, was widely drawn from these observations that animal protein of some kind was an essential ingredient of an effective milk substitute. This view found apparent confirmation in the earlier test with milk substitutes of vegetable origin, in which, however, the important fact was overlooked that whereas the animal substances commonly used as milk substitutes enrich the basal cereal ration, not only in protein, but also in minerals, the vegetable protein-rich foods tested are little better supplied with some of the essential minerals than the cereals themselves. More recent experiments in which this point was safeguarded have shown that protein supplements of vegetable origin, given along with suitable mineral mixtures, are capable of giving just as good growth rates as the commonly used protein supplements of animal origin.

Thus in one of the Harper Adams experiments with lots of ten pigs each, fed for 112 days, the average gains in live-weight per pig for the period, and the efficiency of utilisation of the rations, were as shown below :

Lot	Feeding	Average live weight gain per pig	Average food consumed per 1 lb. live weight gain
		lb.	lb.
1.	Cereals + fish meal	141.4	4.08
2.	Cereals + bean meal and minerals ...	143.7	4.11
3.	Cereals + soya meal and minerals ...	147.0	4.01
4.	Cereals + ground-nut meal and minerals	138.0	4.19
5.	Cereals + mixed soya, ground-nut and minerals	138.8	4.16
6.	Cereals + minerals only	112.5	5.12

The amounts of the protein supplement foods in the rations were adjusted to give the same amounts of protein in each as the 10 per cent. of fish meal used for Lot 1. Bearing in mind that in interpreting the results of experiments of this character, and number of animals per lot, it is necessary to allow about 10 per cent. for normal variation that might arise without any differential feeding, it will be seen that there was no significant difference between the results given by Lots 1 to 5. That the cereals do require a supplement of protein from some

source, however, is strikingly evident from the results with Lot 6, which received the same cereal meals and minerals, but no added protein supplement.

In another experiment in which three lots of pigs received cereals *plus* fish meal, and three other lots cereals plus extracted soya meal and minerals, the following average results were obtained :

Protein supplement	Number of pigs	Average live weight gain per pig	Average food consumed per 1 lb. live weight gain.
		lb.	lb.
Fish meal	30 ...	183.2 ...	3.70
Soya meal	30 ...	178.5 ...	3.76

Again no significant difference.

In a third experiment soya meal *plus* minerals was compared against a mixture of equal parts of fish meal, meat meal, dried skim milk, dried yeast, and pea meal. The percentage of protein in this mixture was practically equal to that in the soya meal, but judged by itself apart from the cereal ration to which it was added, the mixture would commonly be regarded as superior to it from the point of view of protein *quality* in view of the variety of its ingredient meals. Despite this, it did not prove to "nick" better with the cereal ration than the plain soya meal, as the appended results clearly indicate :

Protein supplement	Average live weight gain per pig	Average food consumed per 1 lb. live weight gain
	lb.	lb.
Soya meal	160.3 ...	3.71
Mixed protein	151.9 ...	3.91

There can be little doubt, therefore, that although soya proteins, if they formed the sole source of protein to the pig, would doubtless prove to be inferior to the proteins of fish meal or milk used in the same way; nevertheless, when their function is, as always in practice, to supplement the *whole mixture* of other proteins present in the ration, they are little if at all inferior to the animal proteins. In the widely used ration of 65 per cent. ground cereals, 25 per cent. sharps and 10 per cent. fish meal, about 60 per cent. of the digestible protein supplied comes from the cereals, and only 40 per cent. from the fish meal, and yet rations such as these are often discussed as if the protein supply were entirely dependent upon the fish meal or other protein concentrate used in its place.

The necessity for justifying each addition to a ration by its relations to the other ingredients of the ration may be further illustrated by the results of some of the Harper Adams experiments on mineral requirements. The basal rations used in these tests have been mixtures of barley, maize, and tapioca meals, sharps, and extracted soya meal, and the experiments were designed to indicate what particular mineral deficiencies might need to be remedied in a diet of this character. Until more precise information was available, a complex mineral supplement was

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used consisting of ground limestone, steamed bone flour, salt, ferric oxide, and potassium iodide. It was soon found possible, however, to omit the two last-named, no sign of deficiency of iron or iodine being evident under the system of management followed as outlined above. The mineral mixture was therefore simplified to limestone, bone flour, and salt. Attention was next turned to the bone flour, the most expensive ingredient left in the mixture. This item supplies both calcium and phosphorus, but since any deficiency of calcium can be met more cheaply by limestone, the use of bone flour is obviously only justified if there is an actual deficiency of phosphorus to be made good in the ration. Consideration of the mineral composition of the kind of ration indicated above raises doubts as to the likelihood of any phosphorus deficiency, since both the cereals and soya meal are fairly well supplied with phosphorus. To test the point, two experiments were carried out in which at the same time the need or otherwise for the supplementary salt was tested. The need for a calcium supplement was taken for granted, since abundant evidence of this was already available both from experiments and from practical experience. The experiments ran simultaneously on identical lines, but the pigs in Experiment II were initially rather younger and smaller than those of Experiment I. Each test comprised three lots, all receiving exactly the same meal feeding, and differing only in the nature of the mineral supplements added thereto, as shown below ; the amount of mineral supplement used in all cases being at the rate of 2 per cent. of the weight of the meals fed.

	Lot A (parts)	Lot B (parts)	Lot C
Ground limestone	6	11	
Steamed bone flour	5	—	Limestone
Salt	1	1	only

The average results in live weight increase and efficiency of utilisation of food are given below :

AVERAGE LIVE WEIGHT GAIN PER PIG.

	Lot A lb.	Lot B lb.	Lot C lb.
Experiment I	90.2	93.4	52.1
Experiment II	53.0	52.3	37.3

FOOD CONSUMED PER 1 LB. LIVE WEIGHT GAIN.

Experiment I	3.31	3.20	4.57
Experiment II	3.15	3.19	4.47

It will be noted on comparing Lots A and B that the omission of bone flour in the case of Lot B had no detrimental influence on the progress of the pigs, but that the omission of salt in the case of Lot C caused a very marked retardation of growth and lowering of efficiency of food utilisation, even though the amount of salt in question was barely 0.2 per cent.

No further demonstration of the need for salt was deemed necessary, and from the eleventh week onwards salt was added to the ration of Lot C in each experiment,

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this lot becoming thereafter a duplicate of Lot B. The average results for the remainder of the feeding period after the tenth week are summarised below:

AVERAGE GAIN IN LIVE WEIGHT PER PIG.

	Lot A	Lot B	Lot C
	lb.	lb.	lb.
Experiment I (54 days) ...	79.0	81.7	91.4
Experiment II (103 days)	143.7	146.7	150.6

FOOD CONSUMED PER 1 LB. LIVE WEIGHT GAIN.

	Lot A	Lot B	Lot C
	lb.	lb.	lb.
Experiment I	4.39	4.32	3.86
Experiment II	4.29	4.20	3.71

It will be seen that the close concordance between Lots A and B persisted up to the end, and that once Lot C received its allowance of salt its records came into line with the rest. In efficiency of utilisation of food, indeed, it surpassed the other lots, or, in other words, made up part of the leeway lost during the first ten weeks.

These results, which are in entire agreement with more extensive experiments carried out by Sheehy, in Ireland, demonstrate clearly that rations such as those here in question, need only a little lime and salt by way of mineral supplement. If the addition of bone flour to a cereal-soya ration is redundant, still more useless must it be to a cereal-fish meal or cereal-meat meal ration. There is some evidence, indeed, that the addition of bone meal to rations already adequate in respect of phosphorus may cause an actual lowering of the rate of production. The indiscriminate addition of standard mineral mixtures to all kinds of rations is thus clearly unsound, and the wise feeder will only supply such mineral supplements as he deems necessary after a study of the amounts of the essential minerals already present in the meals he is using.

We have taken the cases of proteins and minerals merely as illustrations of the general principle that the whole ration must be taken into account when considering the desirability of modifications by addition or removal. The effects produced thereby may be specific to that particular ration, and can only be expected with rations that show the same kind of deficiencies or excesses.

ASTHENIA IN PIGLINGS.

By W. LYLE STEWART, M.R.C.V.S.

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SEVERAL years ago I was consulted regarding extensive losses in newly-born piglings occurring in an up-to-date piggery in the North of England. An inquiry into the circumstances associated with the outbreak, and a survey of pathological data, assisted by eliminative reasoning, allowed me to arrive at certain more or less tentative conclusions, which were passed on to the veterinarian in charge of

the herd. While it is true that my recommendations were not completely supported by experimental proofs, they were put into effect, and as two seasons have passed without a reappearance of the trouble, I thought it permissible briefly to describe the condition, which may be of interest to others. If an apology be required for the name "asthenia," may I say that I am entirely responsible. I do not know if the disease has been described, or what it should be called, but "asthenia," implying debility, lack of strength, etc., was chosen as most nearly expressing the clinical manifestation, albeit in a somewhat vague manner.

The piggery consists of about twenty breeding sows and gilts of the pure-bred Cumberland type. Farrowing takes place throughout the year, and under the prevailing system, each female is expected to produce two litters of piglings per year. The trouble had appeared intermittently previous to 1928, but evoked no professional notice. In January of that year, however, there was an unaccountable loss of young piglings from the age of twelve hours to three days. The progeny of two sows were concerned. Both farrowed average litters in an uneventful manner, and the piglings had every external appearance of being well-nourished, healthy, and were eager to suck. According to routine, special precautions were taken to protect the sow and piglings against cold. Nothing abnormal was noted until twelve to forty-eight hours after farrowing, when most of the piglings gradually became disinclined to suck, wandered from the mother, lay by themselves among the straw, and died within twenty-four hours. A number of affected animals emitted a peculiar whine, and sometimes twitching of various muscle groups was observed. In three days the whole of one litter, and half of the other, had succumbed without showing diarrhœa or any other very definite symptom of illness.

The veterinarian in charge was unable, from the history, symptoms, and gross pathology of the carcases, exactly to account for the deaths, but directed strict attention to hygiene and dietetics. Cabbages and raw potatoes were eliminated from the sows' diet, since these foods were not of first quality. From January until the beginning of summer the trouble gradually abated, and finally disappeared, and somewhat naturally it was assumed that these precautions had, at least in part, been successful. Altogether eight litters were affected, and sixty piglings died. Some sows lost their entire litter, others a proportion, and one or two litters escaped the trouble entirely. Once piglings assumed the blasé, drowsy appearance, they scarcely ever recovered, so that the mortality approached 100 per cent. A few pigs did recover, but remained weakly, unthrifty, and not economical to feed. The same disease re-commenced the following January, and I was called in consultation. Again, the healthiest and strongest looking piglings stopped sucking twelve to seventy-two hours after birth, and simply lay separately among the straw until they died. Two litters were affected. The sows were stated to have plenty of milk, but one appeared very restless, as though pained a little internally. Both sows seemed to be in excellent condition.

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Careful post-mortem examinations of newly-dead piglings failed to reveal any gross lesion in any part of the body. The stomachs contained curdled milk in small amounts; the intestines contained bile-stained fluid ingesta, and were clean and free from any suggestion of hæmorrhage or inflammation. The other organs appeared to be normal. A detailed bacteriological examination was carried out in my laboratory on three affected animals, of which the following description may be taken as typical:

Pigling No. 2.—Received alive January 7th, 1929; three days old, and affected for thirty-six hours. Looked weak, trembled, but able to walk, and seemed as though it might recover; temperature normal. Next morning weaker; the back was arched, diarrhœa present, and eyes dull. Killed by chloroform.

Post-mortem.—Clear peritoneal fluid in small amount; pleural fluid ditto; pericardial fluid ditto. Bile thick, tenacious, and bright-golden colour. Kidney showed minute hæmorrhagic spots. Liver normal. Mucous membrane of stomach showed eight little areas of erosion the size of a pin-head. Intestines normal in appearance. Aerobic and anaerobic culture media were sown with material from the following organs and fluids: pleural and pericardial fluids, heartblood, liver, spleen, bile, kidney, cerebro-spinal fluid, brain substance. After seven days' incubation the only detectable micro-organisms were non-pathogenic cocci, which had grown in tubes inoculated with liver and kidney. The other tubes were sterile. Hæmoglobin tests were carried out, and with readings of 60 per cent. to 80 per cent., there was no indication of anæmia.

The staple food of the breeding sows and gilts consisted of a mixture of oats and maize in the proportion of 2 to 1, with a little beans added during the last weeks of pregnancy. These cereals are mixed, scalded, and fed as warm mash after standing for one day. A little green food is allowed, and sometimes bran or middlings is added, together with a little stewed linseed towards the end of pregnancy. Coal and ashes are supplied to the sows to supply mineral supplements. The sows have the run of a paddock until four weeks from parturition, when they come under the above routine. Special shelter and heating are arranged for animals farrowing in winter, and under this system of management the herd has been carried on successfully for twenty years. The sows have maintained good condition, litters have been average in numbers, and there has been no lessened fertility.

It now remained to inquire whether the staple diet contained a sufficiency of mineral matter. Cereals and most other concentrates contain too little calcium, sodium, and chlorine, and in some cases too little phosphorus, iron, and iodine, to meet the needs of a growing pig; and Dr. Orr and his co-workers at the Rowett Research Institute have shown in a conclusive manner how much the rate of growth is influenced by the simple addition of calcium-rich salts to an ordinary cereal diet. An endeavour was made to obtain milk samples from sows in order to submit them to chemical examination. Only one suitable sample was collected from a sow which had lost her entire litter in the manner described. The sow

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had remarkably little milk, and considerable difficulty was experienced in getting sufficient quantity (100 c.c.). The attendant thought this was quite normal, but I was of the opinion that there should have been more milk. (At any rate I certainly should not like to milk sows for a living.)

Mr. Brynmor Thomas kindly carried out the analysis at Armstrong College, with the following result: Calcium (CaO), 0.2330 per cent.; phosphoric acid (P_2O_5), 0.3095 per cent.; potash (K_2O), 0.0383 per cent.; soda (Na_2O), 0.0719 per cent.; magnesia (MgO), 0.871 per cent.; chlorine (Cl), 0.0049 per cent.; total ash, 0.8304 per cent.

The Librarian at the Rowett Research Institute was kind enough to supply the following analysis of sow's milk (Konig): Calcium, 0.395 per cent.; phosphoric acid, 0.357 per cent.; potash, 0.071 per cent.; soda, 0.076 per cent.; ferric oxide, 0.009 per cent.; chlorine, 0.104 per cent.; total ash, 1.012 per cent.

The inquiry now reached the summing-up stage. I failed to incriminate a bacterial agent in the causation of the disease, and there was, further, an entire absence of lesions suggestive of contagious disease. The only abnormality noted was a lethargy or drowsiness which continued until death, with the addition in some cases of whining and twitching of muscle groups. On the other hand, the staple diet of the sows was deficient in mineral matter, and the chemical analysis which we were able to do did not tend to negative the view that the condition had its origin in a mineral deficiency. Was it possible that the mortality was the indirect manifestation of feeding a diet not at all suitable for good milk production? December, January, and February are notoriously the three worst months for farrowing, and conditions which may possibly support the sows at other times conceivably may tip the balance against the piglings at a more critical period.

At any rate it remained to be seen. I recommended the addition of 5 per cent. to 10 per cent. of a good quality fish meal, or, if preferred on the grounds of economy, what I considered to be a suitable mineral mixture, to the staple diet of pregnant sows. The mineral mixture was chosen, consisting of: sodium chloride, 20 parts; ground limestone, 40 parts; bone meal, 40 parts; potassium iodide, 0.04 parts.

This, in small measure, was added to the food during the whole of the period of gestation. Since then two winter farrowing seasons have passed, and I am now informed by the veterinary surgeon, who is in a position to know, that the trouble has not occurred since. Accordingly, perhaps I may be justified in concluding that at least there is a certain amount of evidence for thinking that asthenia in piglings—if asthenia it may be called—is a manifestation of dietetic errors in breeding sows. The value of suitable mineral supplements for growing pigs is well established; is it any less likely that they are essential to pregnant females engaged upon active constructional work *in utero*?

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THE PREVALENCE OF TUBERCULOSIS IN SWINE, AND THE NEED FOR A MORE COMPLETE INSPECTION AND CONTROL OF DAIRY HERDS.

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WHILE a considerable amount is being spent in dealing with cattle under the Tuberculosis Order, a heavy financial toll is imposed on the country annually by reason of the losses meat traders experience through the condemnation of large quantities of meat on account of bovine tuberculosis. A considerable proportion of this meat, of course, includes carcases, parts of carcases, and offal of swine. Another loss, one which cannot be properly measured in terms of finance, is that which is occasioned each year when approximately two thousand persons die from tuberculosis of bovine origin. It has been estimated that these form about 5 per cent. of the total number of deaths from tuberculosis of any origin. Of the two thousand deaths referred to, considerably more than half of them take place before the individual has reached the age of fifteen years.

Tragic though such a state of affairs may appear, there always remains the great problem concerning the care and treatment, in institutions or otherwise, of the thousands of young children who, more or less maimed, live on from year to year with remarkable buoyancy in the hope of recovery. Without discussing the paths of infection, it may be broadly stated that, having regard to the lesions and the relative percentages concerning their regional distribution, as with bovine tuberculosis in the human subject, in the great majority of cases of tuberculosis as affecting swine the medium of infection has been cow's milk. It is more or less a truism to say that tuberculosis in the pig simply means tuberculosis of bovine origin, and, bearing this in mind and the probable paths of infection in the great majority of cases, it may be asked in the light of general knowledge regarding pig feeding: What precautions are necessary to reduce the prevalence of tuberculosis in swine?

In a recently-published report on a survey of tuberculosis of bovine origin, it is estimated on the basis of the tuberculin reaction that at least 40 per cent. of the cows in this country are infected with the tubercle bacillus. In the same report, results given by Professor Buxton regarding seventeen previously untested herds in different parts of England, extending from Devonshire to Cumberland, show that of 661 animals tested, 434, or 65.66 per cent., reacted. It is also stated that at Newcastle-on-Tyne, between the years 1922 and 1925, a careful post-mortem search for lesions of tuberculosis was made, with the result that of 121 cows slaughtered and examined in this way, no fewer than 98, or 78 per cent., were found to be tuberculous. Again, in some experiments on tuberculin testing carried out by the writer some years ago, when all the animals tested—some over a period of years—were slaughtered immediately after the final test for the purpose

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of a post-mortem search for lesions, it was found that amongst the cows about 30 per cent. had failed to react to the subcutaneous method, whilst of those tested by the intradermal method (cows varying from four to nine years), about 14 per cent. had failed to react.

Now according to the experiments referred to, it would appear necessary to add 14 per cent., on account of animals which fail to react, to the 65 per cent. of reactors in the tests reported by Professor Buxton, in order to arrive at the probable total percentage of animals that would have presented visible lesions had they been slaughtered. In this way probably 79 per cent. of the animals would have been found tuberculous, and as 78 per cent. were found tuberculous in the Newcastle post-mortems, it is fair to state that were it possible to make a careful search in post-mortem examinations of a large number of commercial dairy herds, the percentage of those found diseased would probably approach nearer 80 than 40. It is probable that the percentage stated is fairly representative of the percentage of dairy cows actually tuberculous in the country as a whole, and this is supported to some extent by the fact that of the many thousands of samples of milk collected for the biological test at large centres—north, south, east and west—between London and Aberdeen during the past twenty years, the percentage found containing tubercle bacilli averages between six and seven. When we know of the general distribution of diseased cows throughout the country, the high percentage of cows actually diseased, and the practice of using milk in pig feeding in districts where the dairy herds are not under supervision, or where the owners are careless in their methods, it is scarcely surprising to find large numbers of otherwise good carcases of pork tuberculous.

So far as feeding and the possibility of infection through the medium of cow's milk is concerned, it is perhaps interesting to compare the large number of pig heads condemned on account of tuberculosis localised in that region in the cities of Edinburgh and Newcastle-on-Tyne during 1931, with the number of cases in which the distribution of disease necessitated total condemnation of the carcase or only the lungs. In Edinburgh a total of 61 pig carcases was condemned for tuberculosis, and 735 pig heads and 214 lungs were condemned for the same reason. In Newcastle, 36 pig carcases were totally condemned, besides 334 pig heads and 83 sets of lungs. It will be seen then that in both places, whilst there were roughly about three times as many sets of lungs condemned as there were of total carcases, the number of cases in which only the head was diseased and condemned equalled about ten times the number of cases in which it was found necessary to condemn the entire carcase. Tuberculosis in the pig, and the consequent losses occasioned by the necessary condemnation of carcases and organs, is just another of the many signposts emphasising the urgency for a more frequent and regular inspection and general control of dairy herds throughout the country, and when possible the gradual elimination of the disease. Although tuberculin is the most valuable and only deadly weapon at our disposal when proceeding to eliminate the disease, it is quite certain that in the application

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of any scheme designed for the eradication of tuberculosis from the herds of this country, progress will be unduly retarded unless the shortcomings of the test in adult cattle, dairy cows in particular, be clearly recognised and provided for.

Finally, the conditions on the farm necessary for the production of a tuberculosis-free milk supply are perhaps the most important of the steps towards the prevention of the disease in the pig. These, together with good hygienic conditions in the piggery, coupled with due observance of the necessity to sterilise certain foodstuffs, such as is provided for by the Foot-and-Mouth Disease (Boiling of Animal Foodstuffs) Order of 1932, are all essential to any methods intended for the purpose of reducing the prevalence of tuberculosis in swine.

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SWINE FEVER AND SWINE ERYSIPELAS.

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OF the infectious diseases affecting pigs in this country, with the exception of foot-and-mouth disease, swine fever and swine erysipelas are the most important, and are probably those best understood, especially from the point of view of treatment and prevention.

Swine Fever.

In 1914, Greenwood furnished a report to the National Pig Breeders' Association on "The Present State of Knowledge of Swine Fever." It was about the year 1885, when Salmon and Smith distinguished swine fever as a separate disease from swine plague, and by 1900 most pathologists were satisfied that the causal agent of the former was *B. suipestifer*, as opposed to *B. suisepticus*, which was held to be associated entirely with swine plague. In 1903, de Schwenitz and Dorset were able to transmit a disease to healthy pigs indistinguishable from swine fever by means of material free from bacteria. The results of this and later researches were published in 1905 by Dorset, Bolton and McBryde. As these experiments completely altered the existing views on the causation of swine fever, and showed clearly that a filtrable virus was the essential pathogenic agent concerned, a summary of their findings may not be out of place. They showed that the blood of pigs suffering from swine fever is toxic in that its injection into healthy pigs gives rise to symptoms and lesions associated with swine fever;

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such infected pigs are immune to further artificial infection as well as to natural infection with swine fever ; pigs recovered from a natural attack of swine fever are immune to artificial infection ; contact of healthy pigs with those artificially infected is sufficient to cause symptoms of swine fever ; a filtrable virus can always be derived from animals suffering from swine fever, and in many cases the presence of *B. suipestifer* can also be established ; the clinical phenomena following the injection or ingestion of *B. suipestifer* closely resembles those of natural swine fever, but this disease is hardly contagious, and the filtered blood of such animals does not convey it ; animals which have survived the injection or ingestion of *B. suipestifer* have no immunity to natural swine fever.

It seems very clear from the above results that the virus of swine fever is the actual cause of the disease, and that pathogenic organisms associated with the lesions, *e.g.*, *B. suipestifer*, are secondary in character, and may give rise to the commonly accepted characteristic post-mortem lesions. In this respect swine fever would appear to bear a close analogy to canine distemper, in which disease the filtrable virus is the actual cause, but various pathogenic organisms may be found in close association, and may be largely responsible for most of the lesions found post-mortem. The *rôle* played by micro-organisms in virus diseases has been the subject of much discussion and research, but the general idea now seems to be that many such micro-organisms are commonly found " normally " present in healthy animals, and only exert their pathogenic influence when the virus has already made its attack. This view is further strengthened by the fact that an immunity established against the virus will, in many cases, prevent infection by the pathogenic micro-organisms, though they may be found present in various sites in the animal body. *B. suipestifer* is not always present in swine fever cases, *e.g.*, Greenfield states that of 178 cases of swine fever, *B. suipestifer* was isolated only from 80, while in the intestine of 600 healthy pigs it was recovered in 8.4 per cent. Recently Lovell recorded his experiences in the cultivation of the Salmonella group from the tissues and intestines of normal swine, and found there was no evidence to show that they are normal inhabitants of healthy swine, although he found that normal agglutinins against one or more of the various strains of the Salmonella group were developed in 190 out of 202 normal healthy pigs examined. He states that this in itself is not evidence of infection with members of the group.

The commonly accepted diagnosis of swine fever, *i.e.*, lesions in the intestine, is well known. It is interesting to note that within recent times several workers have written on the subject. Geiger (1930) thinks that diagnosis should be based in the first place on the clinical symptoms and post-mortem lesions. In doubtful cases it may be necessary to resort to experimental transmission. He states that in acute swine fever the lesions are those of an acute hæmorrhagic septicæmia, and lesions may occur in the lungs as well as in the intestine. He goes so far as to say that in doubtful outbreaks immunity experiments may be necessary. Nusshag (1930) states that in the acute stages there is no difficulty in diagnosing

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swine fever, but post-mortem examination is often essential. He draws attention to the fact that a recognised character of the virus is that it damages the parenchyma and small blood vessels, and thus causes hæmorrhages in all the organs. The hæmorrhages may vary in extent from the smallest specks to extensive extravasations, and in no other disease of the pig do such hæmorrhages occur. He relies almost entirely in diagnosing swine fever on the presence of these hæmorrhages, coupled with the symptoms present, and the history of the outbreak. Antony (1931) objects to the great stress laid on the discovery of ulcers in the cæcum and inflammatory lesions in the intestine. He finds that petechial hæmorrhages just under the surface of the skin and in the kidneys are always present, and considers them diagnostic. He holds that the intestinal lesions are due to secondary invaders. It will be observed from these references that those who have made a study of swine fever have found for themselves characteristic diagnostic characters based on the nature of the virus rather than on lesions, which are in all probability associated mainly with the micro-organisms acting in a secondary character.

The treatment and prevention of swine fever have been the subject of much experiment. To-day the prevailing opinion in most countries is that the judicious use of the simultaneous injection of hyper-immune serum and active virus gives best protection. Greenfield (1914) gave a statistical survey of the results of the use of the simultaneous injection, and concluded that permanent immunity may be produced, but that there was a considerable risk of spreading the disease. (This view was held by the English and Continental workers, but not by the Americans.) Recent opinions, based on much experimental work and experience on the Continent and America, fully endorse the satisfactory results of the simultaneous method of prevention. The use of hyper-immune serum alone in the prevention and treatment of the disease has only a limited application. Geiger (1930) holds that such a serum alone applied promptly to animals in infected premises, and provided strict attention is paid to hygienic principles, is effective in controlling the disease. Its disadvantages are the brief duration of immunity and the uncertainty whether the treated animals have acquired active immunity. In Germany it is the practice to use simultaneous inoculation on infected premises, using the strain of virus actually responsible for the disease on the premises. Such a method of treatment is said to transmit the disease rapidly and systematically to all the animals, with very small losses, and a lasting immunity is produced. Pigs showing a temperature are given serum only, and a double dose of such serum is said to save from 50 to 75 per cent. of infected pigs. The use of the simultaneous method of treatment is stated to save 95 per cent. of healthy pigs on infected premises. It is very important that virus of sufficient virulence be used. Nusshag (1931) is of opinion that the injection of hyper-immune serum has thoroughly established its value, but because of its failure to produce a lasting immunity, the simultaneous injection method must be used. Care should be taken that young sucking pigs are not subjected to such treatment, as they are

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not suitable for active immunisation. Dorset (1931), in discussing the preventive methods of treatment refers to the " slaughter out " policy, and holds that though it may be useful in dealing with localised outbreaks, it is not applicable to America, where the disease is now so widespread. He is of opinion that the simultaneous injection method is best, and produces an immunity for life. The essentials are virus of full virulence and potent serum which should always be used in excess in order to prevent vaccination losses. Excess of serum does not appear to have any effect on the resulting immunity. In America the simultaneous method has been in use for over fifteen years, 20,000,000 pigs are protected annually, and co-incidentally with its increased application there has been a steady decline of swine fever. Dorset advises that where extensive infection with Salmonella and other organisms is present, serum alone should be used, but where a practically pure virus infection is present the herd may be successfully handled by administering serum alone to all pigs that are visibly sick, or which show a temperature exceeding 104° F., while the remainder are given the simultaneous inoculation.

The literature contains many references to so-called " breaks " involving losses soon after vaccination, as well as breakdowns in immunity. These losses would appear to be due to the treatment of young sucking-pigs, wrong diagnosis of the initial outbreak or the subsequent disease, faulty technique in making the injections, and more especially in the past the use of serum of low potency, or in too small a dose, or of a virus of too low a virulence.

It is evident from the above, and from the recorded experiences of many workers, that swine fever can be adequately controlled by the use of hyper-immune serum, coupled with the simultaneous serum-virus inoculation on infected premises, provided that a definite diagnosis of the disease is made in the first instance, that the serum is of high value, and is injected in sufficient dosage, that the virus is of sufficiently high virulence, that sucking-pigs are not included in the simultaneous treatment, and that reasonable hygienic precautions are observed. As far as we are aware the simultaneous serum-virus method is not practised in this country. The responsible authorities rely on other methods of control.

Research into swine fever continues. Four recently published papers indicate the lines on which work is being done. Rucks and Murray (1931) conducted a series of five experiments to determine whether the cells of swine-fever blood are infective, and showed clearly that they do contain virus, which when released by hæmolysis and then filtered through Berkefeld candles possesses sufficient virulence to produce typical swine fever when injected in minute dosage into susceptible pigs. McBryde, Niles and Cole (1931) showed experimentally that 3 per cent. sodium hydroxide in combination with 2 per cent. milk of lime is effective in destroying the virus of hog cholera in virulent blood within fifteen minutes. Huddlestone and Johnson (1931), bearing in mind that pigs may be infected with contagious abortion (*B. suis.* infection), failed to show that any sample of commercial swine fever serum examined by them contained any *B. suis.* (abortion), and their opinion is that the examination strongly indicates

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that the possibility of its presence in a living state at the time of distribution is rather remote. Curphey (1932) showed that with adequate precautions it is possible to prevent infection of highly susceptible pigs in an environment heavily seeded with the virus of swine fever. He also showed the ease with which the disease is transmitted to susceptible animals by human beings in contact with infective animals.

Swine Erysipelas.

According to Antony (1930), swine erysipelas is found in about 2 per cent. of British pigs at the time of slaughter. In certain districts the disease is apparently quite prevalent if one judges by the amount of preventive treatment carried out. As opposed to the question of causation of swine fever, the *rôle* played by *B. rhusiopathiæ* as the actual cause of swine erysipelas has never been disputed since its discovery by Pasteur and Thullier in 1882, and its characters are well known. Certain premises appear to be constant sources of infection, due either to the persistence of the organism, or to the fact that the organism may be harboured in the intestine of apparently normal pigs (quoted by Hutyra and Marek). It is significant that premises may remain free from infection for many months, and suddenly an outbreak occurs, or an apparently healthy animal may suddenly show diagnostic symptoms soon after being subjected to altered conditions, *e.g.*, a railway journey, etc.

The diagnosis of swine erysipelas does not as a rule present the same difficulty as that of swine fever. The intense depression in the acute type accompanied by a high temperature, the characteristic red, raised, diamond-shaped patches all over the body, the swellings in the region of the jaw, coupled with the superficial type of inflammation of the intestine, are strongly suggestive of its presence. The ease with which white mice and pigeons are infected with the bacillus forms a ready means of confirming the existence of swine erysipelas. Blood taken during the high temperature phase will often contain the bacillus in sufficient numbers to effect infection of these animals by injection. Chronic cases, and many such do occur, present more difficulty in diagnosis. The presence of the typical vegetative endocarditis is, of course, practically diagnostic. Intercurrent disease, *e.g.*, swine fever, may occur, and it is necessary—especially when dealing with supposedly chronic cases—to bear this in mind. The history of the case will be found valuable in coming to definite conclusions.

In the treatment and prevention of swine erysipelas the use of hyper-immune serum is largely resorted to, and, in healthy herds, with it is coupled the injection of living cultures of the bacillus. Lorenz devised a method of prevention which is largely used on the Continent, and which is now being used to an increasing extent in this country. It consists in the simultaneous injection of hyper-immune serum (usually prepared in horses), together with an adequate dose of living culture. Immunity is rapidly established, and to increase it still further, Lorenz advises the injection of living culture alone about a fortnight after the simultaneous inoculation has been made. We have considerable experience of the use of

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Lorenz's treatment in this country, and provided the culture is living and potent, and the serum is of good value, the results are satisfactory. Naturally, such treatment cannot be adopted in animals already sick. Large doses of serum have been found beneficial in such cases. It would be interesting to obtain in England the results of the treatment of swine erysipelas on the lines laid down by Dorset for swine fever, viz., the use of the simultaneous method on the apparently healthy pigs in an infected herd, and the injection of large doses of serum in already infected animals. Valuable results might be obtained if one of the large pig associations would co-operate in an investigation of this kind.

The preparation of the serum and culture for the simultaneous method of treatment is done in Continental countries as well as in England. Cultures of the organism must of necessity be used soon after preparation to ensure their virulence, and serum should conform to a degree of potency sufficiently to " block " the dose of culture. Two methods for the standardisation of serum are in use : (*a*) the German method, in which mice are used ; and (*b*) the Dutch method, in which mixtures of culture and serum are injected into pigeons. In the German method a standard culture of the organism is diluted suitably with normal saline, and is injected in gradual doses intravenously into mice which have received, twenty-four hours previously, a dose of the serum under test, intra-peritoneally. Sera can be graded according to the amount of culture necessary to cause the death of the mice. In the Dutch method, a fixed dose of culture is mixed with varying doses of serum left in contact for an hour, and the mixture then injected intramuscularly into pigeons. The amount of serum in the mixture necessary to prevent the death of the pigeons indicates the value. After many years' experience of both methods, we prefer the Dutch test.

In connection with swine erysipelas, it is interesting to note that, although older references state that the disease does not exist in America, recent publications confirm its presence there.

Swine erysipelas is not a disease entirely confined to pigs. There are many records of its causing arthritis in lambs. In this country Cornell and Glover (1925) published an account of their work in which they recovered cultures of the bacillus from arthritis in lambs, and recently Marsh (1931), working in America, found its presence in two outbreaks of chronic arthritis—in the joints, and in one case in a popliteal gland. Marsh succeeded in infecting healthy lambs by intravenous injection of cultures, but failed by umbilical inoculation. Swine erysipelas may also infect human beings, the condition being known as " erysipeloid." Many veterinary practitioners have recorded the symptoms of such infection in themselves ; it has long been known that the serum is highly effective in treatment. The latest reference is by Crowther (1932), in whose case a rapid cure was effected by the injection of serum.

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INFECTION OF PIGS WITH TUBERCULOSIS FROM MILK.

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THE susceptibility of pigs to bovine tuberculosis is well known. The following short note is yet another example of how infection may occur. On two occasions pigs used for experimental purposes became infected with tuberculosis under conditions which point to infection from milk.

Two young pigs (six weeks old) were being used in an experiment, and were fed practically entirely on milk obtained from an outside source. On completion of the experiment, which lasted about fourteen days, the pigs were transferred to their proper quarters, and the milk ration was replaced by our usual standard diet for pigs. They continued to thrive until about four months old, when both developed coughs, and began to fall away in condition. They were slaughtered when about five months old, and were found grossly infected with tuberculosis. Both thoracic and peritoneal cavities were badly involved. There was no evidence of the spinal column being involved. The type of infection was shown to be bovine.

Two young pigs about ten weeks old were received for investigation work, which lasted several weeks. The pigs were in apparent excellent health. They were subsequently fed with a view to their being sold as porkers. They put on flesh rapidly, and were eventually slaughtered when apparently in excellent health. Examination of the carcases revealed small tubercular lesions in the submaxillary gland of one pig and the prepectoral gland of the other. Cultures of the glands were made, and *B. tuberculosis* of bovine type was isolated from both. These pigs had received milk in the form of washings from the buckets of milk obtained from an outside source for the feeding of ferrets. It is of interest to note here that we found several cases of tuberculosis among the ferrets fed on the same milk. *The milk had been accepted as "pasteurised."*

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SOME ABNORMALITIES IN PIGS.

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THE specimens here described were taken from pigs in the slaughterhouse, so that apart from the fact that all the animals were in good health before slaughter, no histories are available.

PSEUDO-CLOACA IN PIG.—This subject was a gilt bacon pig. In the live animal the external genital organs were normal in appearance, but there was no anus present. Examination of the organs after slaughter disclosed the fact that the fæces and urine were excreted through a common opening—the vulva. The rectum and vagina united about one inch from the vulva, which was of normal size.

TRANSPOSED INTERNAL ORGANS.—A report was recently published of a human subject who had his heart on the right side of the chest, and the other organs correspondingly misplaced. It was stated that only one person in fifty million was born thus. The animal herein described was of a similar nature, and to my knowledge the condition in pigs is just as uncommon as it is in human beings. The subject was a fat bacon pig. On opening the carcase after slaughter, the appearance presented was that of a carcase reflected through a mirror. The spleen, omentum and cæcum were on the right side of the abdomen, and the bulk of the small intestine to the left. The stomach and liver, though not out of place, were correspondingly changed about, the gall-bladder in the latter organ being on the left central lobe. The aorta left the heart from the right ventricle, the walls of which were thicker than the left, and the vena cava returned the blood to the left auricle.

BLADDER COMPLETELY OCCLUDED BY URINARY CALCULI.—Subject : a large white sow. The bladder was packed tightly with small calculi, each one no larger than a grain of sugar, and the whole mass weighed about 10 lb. Just enough urine was present to slightly moisten the calculi, giving the whole the consistency of damp sand. There was no evidence of uræmia in the carcase. On analysis the composition of the calculi was found to be ammonium and magnesium phosphate in almost pure form.

BARBAROUS RESTRAINT FOR ROOTING.—The upper rim of the snout of this animal, a large white sow, had been pierced in four places, and lengths of thick copper wire measuring about six inches each had been inserted. Each wire had then been bent on itself and the ends twisted together, finally leaving four lengths of double-strand wire, each three inches long, hanging from the snout.

CASES of HERMAPHRODITISM AND SIX-FOOTED MONSTERS.—These are not uncommon in pigs. The form of hermaphroditism most commonly encountered is that of a gilt pig possessing two testicles taking the place of ovaries at the ends of the uterine horns. In this case the live animal presents a masculine

appearance in the head and body. The clitoris is much enlarged, sometimes being nearly two inches long, whilst the flow of urine on micturition is directed upwards. This may be due to the enlarged clitoris interfering with the normal flow, or in very rare cases the urethra is continued through the clitoris, and the urine excreted through an orifice in the point of the latter organ, in which case the direction of the flow would be upwards. Less common forms of hermaphroditism are: (*a*) One ovary normal, and the other replaced by a testicle; (*b*) one testicle and one ovary at each end of the uterine horns.

In six-footed monsters the multiple feet are as a rule on the forelegs. Four large claws are present on each leg, but only two accessory claws, the impression being given that the extra foot is really a tumour-like growth on the medial accessory digit.

Irregularities in the number of kidneys present in pigs are common, some animals having three well-developed kidneys, and some only one. The position of the kidneys in the body sometimes varies: they may be found actually as far back as the pelvic cavity. Total absence of the spleen is sometimes encountered, but in this case the probable explanation is that the organ has become strangulated in the omentum and gradually wasted away. Double spleens are occasionally found: they run parallel to one another, and are frequently joined together throughout their length.

PIG DISEASES IN CZECHOSLOVAKIA.

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THE diseases of pigs in Czechoslovakia do not differ much from those in the other parts of Europe. In central Europe there occurs the same disease, and only the number of sick animals varies according to the preventive measures taken against the infectious diseases, and according to the hygienic level of the different countries. Great attention is paid to the keeping and breeding of pigs, especially in the agricultural regions. The consumption of pig meat is very large, and although the pig breeding is on a high level, pigs and pig meat are imported from the neighbouring countries, especially from Hungary and from Poland. For this reason there are some severe measures on the frontier against the contagious diseases, and each transport is carefully examined by special veterinary surgeons. This is one of the important services of the veterinary officers.

It is not quite possible to give a detailed outline of all diseases of pigs in Czechoslovakia. There are always diseases which occur in some regions more often than in others, and also the number of sick animals varies from year to year in different parts. There is a higher agricultural level (living standard) in the western part of Czechoslovakia than in the eastern one, where more and more often infections and parasitical diseases are found.

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The Veterinary University College has been erected in Brno, the capital of Moravia, which is more agricultural than the more industrial Bohemia. Brno itself is situated in the neighbourhood of a country where breeding (keeping) of cattle, pigs, etc., is carried out on a very high degree. It is, therefore, possible to give a more precise picture of the diseases of pigs in the Brno district.*

Of all treatments during the last ten years undertaken by the Buiatric Clinic, 34.1 per cent. were diseases of pigs. The cattle form only a majority of 57.7 per cent., and the remainder the other animals. All these diseases of pigs can be divided into five groups:

(*a*) Diseases which needed surgical treatment, 32.9 per cent. The greater part of the treatments were of a surgical nature. It must, however, be added that in this group were included castrations (30.7 per cent.) of normal animals or animals where castration was necessary.

(*b*) Preventive and therapeutical inoculations against dysentery, 30.4 per cent.

(*c*) Infectious diseases, 17.9 per cent. The majority of infectious diseases were dysentery (81.4 per cent.).

(*d*) Non-contagious and non-parasitic diseases, 16.2 per cent. In this category of diseases, diseases of the alimentary canal come first (42.9 per cent.), and are followed by diseases of metabolism (19.2 per cent.), where the greater part comprises rachitis and osteomalacia.

(*e*) Parasitic diseases, 2.6 per cent. Only a very small group is formed by parasitical diseases (2.6 per cent.), which may be a sign of good hygienic measures in this district. It must be mentioned again that these statistics refer only to one region which can be controlled particularly by the clinic. There will be, however, no great difference in other parts of Czechoslovakia—at least, no fundamental ones.

SOME NOTES ON CERTAIN DISEASES OF PIGS IN GERMANY.

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In Germany there is an organisation composed of the staffs of veterinary bacteriological and other institutes of the several provinces called "The Imperial Centre for the Combating of Diseases Bearing on Livestock Rearing." The members hold a congress every second year, the last one taking place at Leipzig in October, 1931. The information given below is obtained from the last report of the centre, which covers the two years from March, 1929, to 1931. The work performed is largely diagnostical, and the receipt of material depends on the voluntary co-operation of stock owners. Sterility in swine was not observed in many cases. Proescholdt (Stettin) observed sterility in thirteen herds of sows,

* I am obliged to Professor A. Klobouk, the Chief of Clinic, who kindly gave the accompanying statistics.

and ascribed the cause to a uterine infection with streptococci, and less often with a Salmonella species. Cystic degeneration of ovaries was also found. The same worker also saw aspermia in two boars.

Abortion in sows was quite common. Twelve institutes examined 409 fœtuses, 107 blood samples, four placentæ, and two uteri. More than half the fœtuses were negative bacteriologically, and half the remainder had a *B. coli* infection, but it was doubted whether the abortions could be put down to this factor. *Brucella abortus* was found in 5.6 per cent. of all cases of abortion, and streptococci in 4.4 per cent. Salmonella strains were also found in a few cases. Five blood samples contained *Brucella* agglutinins, and four agglutinins for *B. abortus equi*.

Diseases of new-born pigs received much attention, and eighteen institutes examined nearly 11,000 specimens or carcases, a fact which is a good illustration of German thoroughness and enthusiasm. The pig rearing industry is of considerable size in that country. The majority of all these cases were not of bacterial ætiology, and the compilers of the report, Professor Miessner and Dr. Koeser, comment on the decreasing importance of bacteriology and the increasing importance of dietetic and hygienic factors in the ætiology of disease.

Of the diseases of bacterial causation in the young pigs, most were ascribed to coliform infection (16.2 per cent. of total specimens), and in this connection Hobstetter (Jena) found by observation that most deaths from this cause occurred between the twentieth and thirtieth day of life. Pasteurella infection came second (10.2 per cent.), but acute swine plague was only rarely observed. In many cases a mixed infection with *B. suisepticum*, *B. pyogenes* and streptococci was found in association with pneumonia, pleurisy and pericarditis. Knauer (Königsberg) declared that swelling of the spleen and hæmorrhages of the kidney cortex are pathognostic of streptococcal sepsis which follows navel infection.

B. suipestifer was isolated from 233 cadavers, and of the paratyphoid bacteria the Breslau strain was found nine times and the Gärtner strain thirty-nine times. Zwick (Giessen) isolated *B. pyosepticum* from one pig, and supposed it to have gained entry through a wound in the tongue. A peculiar condition of the heart in young pigs—multiple localised degeneration of the myocardium—was observed. Karsten (Hannover) considered it a sign of intoxication, and Knauer (Königsberg) considered it was caused by *B. bipolare*. An apparently specific rhinitis of young pigs was observed in the Königsberg, Breslau, and Hannover districts. *B. pyocyaneus* and *B. pyogenes* were found in association with it; the deformation of the nasal region was, however, ascribed partly at least to a condition of rickets.

Of all non-bacterial conditions encountered, affections of the alimentary tract were commonest—gastritis and enteritis—and it is stated that the cause of a great many of these was distinctly puzzling. Dietetic errors, including sudden changes in rationing, were believed to be important in this connection. Zwick (Giessen) laid stress on a careful examination of the intestinal tract in all cases. Death is not uncommonly caused by worm infestation, notably by *Strongyloides* and *Trichocephalus*.

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NOTES ON ASCARIS AND LUNGWORMS IN PIGS.

By E. LEONARD TAYLOR, B.V.Sc. (Livpl.), D.V.H., M.R.C.V.S.
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THE veterinary helminthologist is a rare bird in the British Isles, and although there are several workers trained for research on parasitic worms from a biological point of view, the number of those who have also been trained for the study of animal disease is very small, and can be counted on the fingers of one hand. It is not because of the unimportance of worm diseases that they have been so neglected, but, as pointed out by Hall, this has doubtless come about through the insidious nature of their onset, which provides nothing to startle us into attention. A news editor might be glad to give a headline to some report of a rapid and terrible disease causing the death of fifty pigs, but a story of fifty thousand or more pigs thriving badly in various parts of the country would appear to him to be very dull.

It is doubtless this same reason which has been responsible for the lack of consideration which up to the present parasitology has received in the veterinary curriculum, and for a certain tendency for a bacteriological outlook upon all " infectious " diseases which veterinarians in general may be said to have. It is, therefore, not surprising to find that many have never realised the significance of the fact that each individual parasitic worm begins its life outside, and there is no multiplication in the host. The state or condition of that " outside " is of supreme importance to the parasitic worms, and the " third factor " plays a much greater part in the production of disease by these parasites than in the production of bacterial or virus diseases. The co-existence of the parasitic worm and the host is not enough, the suitable environment must also be present for the worms to increase to disease-producing numbers.

One of the principal lines of endeavour in finding some means of control for parasitic worms is to study the effects of individual environmental factors upon the free-living eggs or larvæ, with the object of learning how to alter the environment of the host in such a way that the multiplication and transference of the parasites is discouraged. The most important and the most obvious third factor concerning the increase of parasitic worms is the intermediate host which is required in some instances for their development, and it is almost essential to know this before suitable means of control can be suggested. Until 1929, no one had succeeded in demonstrating how pigs become infected with lungworms; various suggestions had been made, and it was generally thought that the life history would eventually prove to be a direct one, but this was not so, the presence of earthworms was found to be necessary to act as intermediate hosts for the completion of the life cycle.

It has been found that several species of earthworms are suitable, that the infective-stage larvæ of the lungworms is reached in about ten days, and can remain alive in the earthworm for several months. The stages through which the

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larvæ pass, their migration in the earthworm, and their final situation there, are all very interesting, as is also the observation that after being swallowed by the pig their migration to the lung takes them through the mesenteric lymphatic glands and the lymphatic vessels, the blood stream being reached *via* the main lymphatic duct. What is of the greatest importance, however, from the point of view of control, is that earthworms are essential to the development and transference of these parasites from one pig to another. To eradicate earthworms would, under most circumstances, be neither desirable nor practicable, and for the control of this parasite something must be done to keep the pigs away from earthworms. How long the earthworms may carry infection, or how long the lungworm larvæ may remain alive in the soil after the disintegration of the earthworms, is not known, and at present no limit can be stated with certainty as to the length of time which the ground remains infective. These are important points which are yet to be determined.

The operation of the third factor is less obvious where no intermediate host is required, but it none the less plays a part of major importance. The life history of ascaris is direct in so far that no intermediate host is required; the eggs, however, are not capable of any further development in the pig until they have spent a period of from three to eight weeks on the ground, the requisite time varying with the suitability of the environment. This parasitic worm is a very prolific one, each female lays something like 200,000 eggs daily, and the uterus has been variously estimated to contain 27,000,000, 64,000,000, or 70,000,000 eggs. It is therefore obvious that only a few find the right environment for development, and only a small proportion of those which do develop to the infective stage are ever fortunate enough to reach the intestine of the pig. An important third factor in the production of heavy infection with ascarids in pigs is, therefore, the suitability of the environment for egg development and survival. Since the introduction of infection may be taken for granted, this factor can be regarded as the principal one in the causation of ascariasis.

Apart from the hookworm of man, we perhaps know more about the bionomics of *Ascaris lumbricoides* than of any other species of parasitic worm. Some years ago it was shown that ascaris eggs are able to remain alive in a suitably moist and sheltered environment in the laboratory for a period of five years, but more recent observations indicate that the survival period is much shorter in the open. One investigator failed to find any viable eggs after twenty-two weeks, and another showed that twenty-one days in sandy soil during hot weather was sufficient to kill them, while thirty-seven days in the dryness of an ordinary room also proved to be lethal. The eggs were, however, found to survive in soil out of doors throughout the six winter months, and it is concluded that the most powerful natural lethal factor is dryness.

Most of this work has been done on the human strain of *A. lumbricoides*, and although the observations probably hold for the porcine strain also, there are several details concerning the environment which might repay for investigation.

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Conditions appear to be better adapted to the development of the eggs in porcine than in human fæces, and although the eggs show a remarkable resistance against strong solutions of formalin or of mineral acids, they are unable to survive for long in fermenting human urine. The reason for this is probably to be found in the digestion of the albuminous coat of the eggs by various enzymes in the urine, this coat being coagulated by the acids and by formalin. It has not been shown whether this observation also holds for pig urine, but it suggests that a light soil in open fields, if much used by pigs, might be even more dangerous for ascariasis than a dirty pig-sty.

A branch of helminthology which is engaging the attention of many workers in various parts of the world at the present time is that of immunity to worm parasites. The differentiation between an acquired immunity which develops as a result of previous infection, and an age immunity which automatically develops as the animal grows towards maturity, is one of the most obvious problems. To quote two examples of each, it might be mentioned that dogs acquire an immunity to *Strongyloides*, and rabbits to *Trichostrongylus*, after infection, while, without need for any previous infection, chickens become immune to gapeworm at eight or nine weeks of age, and dogs automatically develop an immunity to hookworm as they approach maturity. There are, however, a number of borderline cases where the nature of the immunity is difficult to determine. Mature dogs, for instance, rarely carry *Belascaris* ; but so few puppies escape infection in early life that no one can say whether the immunity of mature dogs is acquired, or is merely an age immunity. Furthermore, it is the observation of many workers that the majority of pups are infected with these worms before birth, a complication which greatly adds to the difficulty of the experimental determination of this interesting point.

There appear to be no reliable records of the occurrence of pre-natal infestation of pigs with ascarids or lungworms, and that point does not arise ; but it is the general experience that mature animals are comparatively immune, the immunity probably being of the type which depends upon age. All our preventive efforts must, therefore, be directed towards protection from mass infection in early life, not altogether forgetting that complete protection may just possibly be a bad thing.

A good anthelmintic is a most useful thing in veterinary practice, and, providing that it is safe, cheap, easy to administer, and effective, is of great value, and may be one of the best means of eliminating worm disease. There are, however, no suitable anthelmintics for the treatment of lungworms in pigs, treatment for ascarids is of very limited value, and the importance of these drugs in general is apt to be over-estimated. It is not through any advance in the knowledge of anthelmintics that the worms parasitic in man have almost been eliminated from the most highly civilised countries, but because of advances in hygiene ; the things which men handle and eat are not in any way contaminated with human fæces, and meat is inspected. It is difficult to introduce sanitary measures for

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animals, and particularly where they are at pasture, and the food is always more or less contaminated with fæces. Requirements for the control of worm diseases are, however, not so great in those instances where mature animals are immune, and it is practicable to arrange some system of control with hygiene as its basis.

On these grounds, the swine sanitation system for the control of ascaris has been introduced in America, and has produced good results. The principle of this system is to prevent young pigs from access to contaminated yards and pens, and to take each litter along with the sow to some field which has not been used by pigs for one or two years. There the pigs are kept with some temporary shelter from wet and cold, until they are three months old, when they are considered to have passed the most susceptible stage. The same system, or some modification of it, may prove of value for the control of lungworms, and when more is known about the duration of infective material in the soil, and of the nature of the immunity, its application may appear to be much more simple.

DISEASES OF THE CIRCULATORY ORGANS OF THE PIG.

By W. JACKSON YOUNG, F.R.C.V.S., D.V.S.M. (Vict.)
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NOTWITHSTANDING the fact that diseases of the heart in the pig are seldom successfully treated, they are nevertheless of considerable importance owing to the losses they cause, and also because they act as warning signals that contagious or infectious disease exists, or is developing. Many outbreaks of contagious disease are brought to light after a pig has died suddenly. Carefully conducted autopsies very frequently reveal lesions of pericarditis, and other changes in the heart that arouse suspicion. The symptoms of acute serous fibrinous pericarditis are indefinite, but dullness, inappetance, difficult or laboured breathing, cyanosis of ears and buttocks, with an inclination to what might be termed " right-sided decubitus " might be observed. Forced movement causes distress and palpitation. Post-mortem examination reveals an increased vascularity of the membrane and loss of the normal glistening appearance. There is profuse exudate, producing a roughness, and extending along the connective tissue of the large vessels at base of heart. The terms " shaggy " and " bread-and-butter " assist in describing the appearance of the inflamed membrane.

Hæmopericardium.—This term appears in veterinary literature, and signifies an accumulation of blood in the pericardial cavity. In the writer's experience, the most common source of the blood is from a rupture of one of the coronary arteries. A history of illness, or an accurate description of the symptoms, is seldom obtained, and one is simply informed that it was a surprise to find the pig dead.

Rupture of the Heart Wall is commonly encountered after pigs have undergone transit and been roughly handled. In such cases there is usually a history of

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over-exertion, the animal having been chased by a dog or other animal. The condition ought to be looked for in sows that collapse after farrowing.

Rupture of the Right Auricle is not uncommon, and follows over-exertion, and sometimes is associated with swine erysipelas.

Angina Pectoris.—It does not appear to be decided as to whether this condition does in fact occur in the pig. A condition closely allied to it, however, is not rare, and occurs in warm weather. The writer has seen many pigs dying from painful heart attacks, and suffering excruciating agony for several minutes prior to death. Some of the affected animals have adopted a sitting position, and in a recent case the left fore limb was fully extended, and the animal squealed with pain. The onset of the symptoms was sudden, and death took place within ten hours.

Traumatic Pericarditis is not common. The writer has only encountered four cases since 1898. In the last case a piece of bass from a broom was found.

Verrucose Endocarditis.—This lesion is met very commonly, and is mainly associated with swine erysipelas. It is also caused by the action of streptococci, and such organisms are capable of producing similar lesions in horses and bovines. The valves on both sides of the heart may be affected, but the left side is the more common site for a well-developed lesion. The condition when found should not stop the examiner from making a search elsewhere for lesions of swine fever. In conjunction with the heart lesion, one finds œdema or emphysema of the lungs, impaction of the large bowel, and bile staining. In some districts pig-owners call the condition "thumps," or describe the pig as a "panter." The thumping action of the heart can be heard for some distance. There is usually some cyanosis of the ears, extending some distance along the back and up the limbs as far as the carpal and tarsal joints. The snout and perineum may have a purplish colour.

General Remarks.

The pig is very susceptible to diseases of the heart. Many cases of pericarditis are found in pigs immediately following weaning, and possibly the absence of warmth derived from the dam is a contributing factor. Unbalanced rations, damp and insanitary conditions, and want of food, pave the way for such trouble.

BACON FACTORY INSPECTION.

By D. J. ANTHONY, M.R,C.V.S., D.V.S.M.

Chief Veterinary Inspector, Messrs. Marsh & Baxter's Bacon Factory, Brierley Hill.

A VETERINARY surgeon employed as meat inspector in a modern bacon factory not only inspects meat in the fresh, frozen, or chilled state, but is frequently called upon to pronounce an opinion upon the products into which such meat is manufactured, and is able to obtain some knowledge of the various by-products of the meat industry.

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Ante-mortem Inspection.

The veterinary officer's first duty is to institute an efficient system of inspection, and this must commence at the railway siding where the livestock arrives, or, in the case of animals arriving by road (motor transport), at the unloading decks in the lairages. A strict watch should be kept on all animals during the unloading and whilst resting in the lairages prior to slaughter. The inspector should insist upon the animals being rested at least forty-eight hours before slaughter, and during this period he should pay frequent visits to the lairages, keeping careful observation for any clinical signs of disease in the pigs, such an inspection being especially necessary for pigs coming from a swine fever infected area, or when outbreaks of foot-and-mouth disease are reported in various parts of the country. When the lairages are full, the inspector must expect trouble. Pneumonia often supervenes a railway journey, in winter and spring especially, and unless great vigilance is exercised, one may soon find a dead pig or two in the pens. Deaths in transit are by no means uncommon amongst pigs, and are usually due to suffocation owing to overcrowding, assisted by the habit some breeders have of giving their pigs a hearty meal before entraining. The stomach, engorged with food, presses down on the diaphragm, and if the waggon is overloaded, the pigs may be lying on top of each other, then woe betide the one whose heart action is at all impeded by a surrounding layer of fat. Other causes of deaths in transit are swine erysipelas, swine fever, fractured bones, and bruises, with internal hæmorrhage due to fighting, especially if a sow or two has been placed in the same wagon as a number of " clear " (bacon) pigs. A daily inspection of the live stock in all lairages is therefore the first essential to a sound system of veterinary inspection in any bacon factory.

Post-mortem Inspection.

If the pigs are intended for bacon production, the heads are first severed immediately the carcases leave the scalding tub, and in such cases the post-mortem inspection commences with the inspection of the submaxillary and parotid lymph glands of the head. These are examined as usual by incision under a good light, preferably an " artificial daylight " lamp. Should any disease or abnormality be noticed in the head or carcase, *e.g.*, skin lesions of swine erysipelas, etc., the head and carcase should be detained for a special detailed examination. This can be done by placing a label or tag on the pig, with a corresponding one, duly numbered, on the head. The internal organs from such pigs are examined immediately they are removed from the carcase, and the carcase itself is carefully examined after splitting down the vertebral column. The examination should be done in accordance with the Ministry of Health's recommendations of 1922.

The " plucks " or " frys " (lungs, hearts and livers) should also be examined in all cases ; the bronchial, mediastinal, and hepatic glands being incised. An incision should also be made between each liver lobe, as this is a frequent site of a hydatid cyst. The plucks are examined after removal from the carcase and washed in cold water, the hearts being split open and freed from blood clots.

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In large factories with a chain of retail shops, the plucks are the first of the " fresh offal " to be sent out daily, so that it is essential that the veterinary officer should pay particular attention to the inspection and preparation of these commodities.

In modern bacon factories the slaughtering and dressing is done with the aid of machinery, such as electric instruments for humane slaughtering, scraping machines for removing the bulk of the bristles, an endless chain to push the carcases along an overhead rail throughout the slaughterhouse and over the weighing scales into the cooling rooms. With the aid of modern machinery it is possible to kill a thousand pigs daily on the " endless chain " principle, the carcase being moved along from man to man, each one performing some operation thereupon as it passes by.

When the killing is over and the heads and carcases are all in the cooling room (this should consist of a large open area, roofed in and well ventilated, the sides being composed of iron railings instead of walls), the inspector should take a walk through the rooms and look at the split sides to ensure that nothing has been missed in the first inspection. When this is over he will probably find other duties awaiting him : casualties—broken legs in transit—emergency slaughtered animals whose carcases have been sent on from the ports of landing in this country. These usually arrive wrapped in canvas bags. In warm weather and the damp misty weather of late autumn and early winter, such carcases often arrive at the factories in a decomposing state, as well as being badly fly-blown. Such are condemned outright, as the danger of food poisoning developing from products manufactured from such meat is very great.

All bacon and hams for export have to be inspected before packing, and a certificate must accompany the goods to the effect that such products are derived from animals examined by ante- and post-mortem veterinary examination, and found free from disease. Foreign Governments insist upon such certificates being signed by a veterinarian. Occasionally (*e.g.*, in the case of the U.S.A.) such a certificate has to be signed by the medical officer of health for the district, who has never seen the livestock, nor knows how to perform ante-mortem inspection upon animals. However, it seems to satisfy the health authorities of the United States of America.

To know how to examine by-products, the veterinarian should study the various process of manufacture. The condition known as " taint " in hams and bacon is one, amongst others, that will require his attention. This is a stage of putrefaction due to anaerobic organisms entering the meat, and can be detected by inserting a clean " trier " or steel skewer into the meat—usually near the bone in a ham or into the shoulder region in a " side " after curing and maturing. On withdrawing the skewer the characteristic putrefactive smell can be detected if the skewer be held close to the nostrils. In advanced cases the hams may be " blown," or emphysematous. It should be the inspector's aim to lessen the incidence of this condition by taking into account, and endeavouring to eliminate, all the factors contributing to cause " taint." One of the commonest and most

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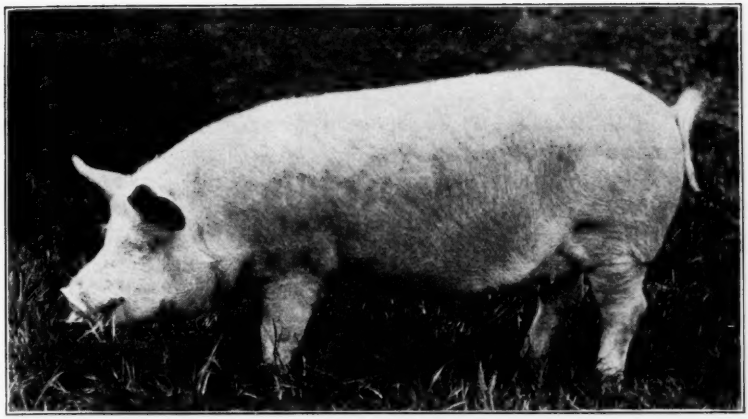

AGRICULTURAL COLLEGE LIBRARY NOV 17 1932 MANHATTAN KANSAS

The ideal pig required by the Midland curers.

(Article by J. Anthony, M.R.C.V.S., *page* 442)

(Photograph from Economic Series Report No. 12, by permission of the Controller of H.M.S.O.)

FIG. 1.—The electro-lethaler applied.

(Article by Dr. Max Müller, *page* 452)

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well-known causes of the trouble being, allowing the carcases to hang too long after slaughter before disembowelling, thus enabling bacteria from the alimentary canal to invade the tissues. Such organisms may include some of the " food poisoning " groups, hence the veterinarian should see that the animals are rapidly disembowelled after slaughter. The manufacture of small goods, such as sausages, pies, potted meats, and canned goods, are all trades apart, and a veterinary officer in a bacon factory where such goods are manufactured has an excellent opportunity of enlarging his knowledge of such commodities, as well as being able to offer advice regarding some of the difficulties met with in their preparation. The examination of sausage casings made from pig, sheep and cattle intestines is also a duty falling upon the veterinary officer : he should be able to examine and pronounce an opinion upon imported " casings," and to certify the fitness of casings for export. In dealing with waste elimination, he should be in a position to advise as to the material suitable for fat extraction for soap and tallow, bone and meat meal, blood meal, and various chicken and dog foods, etc. His knowledge of anatomy is useful in the saving of the endocrine glands for extraction work, and the examination of pigs' stomachs for use in the manufacture of pernicious anæmia remedies.

Refrigeration plays a most important part in a bacon factory, or any food factory, and the veterinary officer should make this a special study. Various other problems continually arise where the services of a trained veterinary surgeon are most useful, especially when combined with the services of a competent staff of chemists. Scientific pig breeding and feeding farms attached to large bacon factories afford the veterinarian an opportunity of enlarging his knowledge regarding nutrition and disease control in herds. It is almost unnecessary to mention that the veterinarian should insist upon absolute cleanliness throughout the factory where food is prepared. Progressive bacon curers realise this vital necessity, and as a rule a special staff is employed in the cleansing and disinfecting of rooms and fittings, whilst workpeople wear clean washable overalls when at work, and are usually provided with adequate facilities for ablution, etc.

Of the general diseases and pathological conditions likely to be met with in the examination of pigs, the following list is compiled from information regarding the inspection of over half a million pigs of all ages, of which 16 per cent. were harbouring disease. Over 9 per cent. of these pigs were tuberculous, so that of the total pathological conditions found in these pigs, just over one-half was due to the tubercle bacillus. Apart from tuberculosis, which forms fully one-half of the inspector's work, the following conditions were also found :

SWINE ERYSIPELAS.—This is very prevalent, especially in the eastern counties of England.

SWINE FEVER.—Few cases are likely to be seen in a bacon factory, as the pigs arriving there are all " finished " animals.

PLEURISY, PNEUMONIA, AND PERICARDITIS are often found, either separately or together, as an extension from a case of pneumonia or pleurisy.

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ENDOCARDITIS.—This may either be the typical vegetative growth found associated with swine erysipelas, or else a tiny " blood bladder " on the heart valve.

HEPATITIS.—Usually in the form of an abscess in the liver, in which may be found a foreign body, such as a sewing-needle, cane from a broom-head, etc.

CIRRHOSIS, or chronic interstitial hepatitis, is common, and is often found in very young pigs, " suckers " eight weeks old. The degree of cirrhosis varies from a few fibrous spots to complete hardening of the liver.

ASCARIDES SUILLÆ often cause trouble either by completely occluding the bowel lumen or by invading the ducts of the liver and pancreas.

FASCIOLIASIS, or Liver Fluke Disease, is often seen in pigs, especially in the livers of sows.

STRONGYLOSIS is not often seen in bacon pigs, and then only in a very mild form.

GASTRITIS may be due to irritants in the food or to foreign bodies in the stomach.

PERITONITIS is often seen as the result of castration or " spaying." (In connection with the latter operation, it is interesting to note that some bacon curers who are also big pig-breeders will not allow this operation to be performed on their gilt pigs. A bony plate often forms in the fat of the flank at the site of the wound in spayed gilts, and this spoils the side of bacon, and where it is unnoticed may ruin an expensive bacon-slicing machine in a shop. I have heard it said by a veterinary surgeon that the spaying of gilt pigs is resorted to because if the gilt is slaughtered whilst in œstrum, the bacon will not cure properly. There is no foundation whatsoever for such a tale, as thousand of gilts in œstrum are slaughtered, and the meat cured daily without any ill effects.)

ENTERITIS is chiefly due to some injury, such as hernia, which is usually umbilical, and may result in strangulation of the intestine.

CONGESTION OF THE SPLEEN is often seen in sows, and is usually physiological rather than pathological, whilst the spleen is sometimes strangulated in the omentum, there being hardly any spleen tissue left.

HYDRONEPHROSIS is common, and one or both kidneys in the same animal may be affected.

NEPHRITIS is occasionally seen, chiefly pyelonephritis.

FAT NECROSIS is found to affect the fat in the region of the pancreas and kidneys.

CAVERNOUS ANGIOMA of the liver is sometimes seen in sow livers, whilst degeneration, *e.g.*, fatty degeneration of the liver, is rare, a commoner degeneration being a colloidal degeneration of the pancreas, which may be a forerunner of fat necrosis.

PYÆMIA, or abscess formation in the tissues, may occur in any part of the body. The dental sinus in the inferior maxilla is frequently the site of an abscess, so also are the deep muscles of the shoulder and hams.

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GANGRENE is rare, but may result from a neglected bite.

BONE FRACTURES are common, especially fractures of ribs. It is surprising how many pigs at a post-mortem examination are found to have old healed-up fractures in one or more ribs. Occasionally a fractured end of a rib will penetrate the lungs, setting up an empyæma. Fractured leg-bones are also common in shipping and rail transit.

JAUNDICE AND EMACIATION, ŒDEMA AND EMACIATION.—These conditions are often due to advanced cirrhosis of the liver, or to either ascarides or live flukes entering the bile ducts.

MESENTERIC EMPHYSEMA is rare in pigs. The mesentery appears to be covered with little gas bubbles, which are especially prevalent beneath the peritoneal covering of the intestines.

VOLVULUS OF THE INTESTINE is usually due to a mass invasion of ascarides.

BRUISING is common, due to fighting, especially if a sow be loaded in a railway waggon with a lot of "clear" or "bacon" pigs. Drovers' sticks may also cause extensive bruising. Deaths in transit are common, due to fighting, suffocation from overloading, overfeeding, and swine erysipelas, etc.

Not the least important part of the bacon factory veterinarian's duties is the keeping of proper records of killings, diseases, meat condemned, etc. It is useless keeping records merely of "so many tons of meat condemned for tuberculosis, so many tons for other diseases, etc." The records are kept daily, and made up weekly into reports giving the total pigs killed and examined, total detained for further examination, the diseases, with columns opposite giving the numbers of carcases and organs condemned for each. It is thus possible to estimate the extent of disease in the pigs. These reports are submitted to the Ministry of Health and the local medical officer of health each week, whilst an annual summary is made up soon after December 31st each year, and forwarded to the same authorities. This annual summary embodies statistical information in detail regarding the year's killings and the incidence of disease, as well as information regarding any special outbreaks of disease, or some particular activities of the veterinary staff throughout the year.

A factory with an average daily killing of 300 pigs should find the services of one veterinary officer sufficient, but where the killings exceed that figure, then it may be necessary to employ more than one veterinarian. Where a number of retail shops are attached to the factory the veterinary officer need not confine his activities to the factory alone. Should his time and staff permit his doing so, he will benefit the firm and public health by an occasional surprise visit to the shops, thus keeping shop managers and assistants up to mark as regards the detecting of any unsoundness in the goods under their charge.

Should a veterinary surgeon employed in a bacon factory decide to confine his activities to the inspection of fresh meat alone, his job will be an easy if somewhat monotonous one; but if he is to be of any use to the firm that employs him

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and to his profession, he should miss no opportunity of enlarging his knowledge and activities in connection with every branch of the meat industry that comes under his notice, as it is only by so doing that we in this country in the veterinary profession can convince people that we are quite as capable of directing slaughtering establishments, and making ourselves useful both to the general public and the meat trade, as are our Continental colleagues.

TYPE OF PIG REQUIRED BY THE BACON CURER.

By F. W. JACKSON, B.Sc., A.I.C.

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It is a well-known fact that the most obvious truths are those which are often forgotten or overlooked. No one would dispute for a moment that the most powerful agency in the industrial world is the ultimate purchaser of manufactured goods. Yet this fact is very easily lost sight of by the supplier, and cases are numerous in which the manufacturer has endeavoured to foist on an unwilling public something which it does not want. How necessary it is, then, that the likes and dislikes of the consumer should always be kept in view. In no industry is this point more important than in bacon curing. During the past fifty years there has been a profound change in public preferences with regard to bacon. These changes are partly the result of a higher standard of living, partly due to other changes of social and economic origin: they have been accelerated and stimulated by the supplies of cheap Danish bacon of uniform quality which have dominated our markets in recent times. It is now fully recognised that, in general, the public requires lean bacon, and that produce carrying an undue proportion of fat, however excellent it may be, is only saleable in certain well-defined areas. Again, bacon is now purchased in small quantities, as and when required, and is not expected to keep fresh for very long. In addition to these and other points where the consumer's taste is of paramount importance, the retailer must also be considered. He knows that the "middle" portion of the side is most in demand. He therefore requires a long side of bacon, with as light a fore-end as is possible. The weight of the side which the retailer prefers varies somewhat in different districts, and is bound to be taken into consideration.

These are just a few of the points which make it desirable to formulate a specification for an "ideal" pig; by which term we differentiate an animal which meets in all respects the requirements of curer, retailer, and consumer alike. The ultimate object, of course, in drawing up this standard is to improve the average quality of British produce so as to make it better fitted to compete with the imported article. For the truth is that, though British bacon is, at its best, the finest in the world, yet there is no guarantee of quantity or uniformity. A retailer who requires a uniform article is therefore induced to purchase Danish,

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of which the supplies are always forthcoming, and of unvarying quality. This term " quality " may need some little explanation. It is a complex term which collectively expresses all those characteristics which are sought by the retailer and consumer. It characterises the difference between two sides of bacon, which may be cured in similar fashion, and may, indeed, possess the same weight, but while the retailer is willing to purchase one side in quantities of a hundred at a time, he will not look at the other at any price.

Quality may be determined by two groups of characteristics which may be called " external " and " internal." Although to the uninitiated all pigs are much of a muchness in external appearance, yet the curer has no difficulty in rejecting many pigs as unsuitable for his purpose, since he knows that length, lightness of shoulder, the size and shape of the ham, and the general appearance of the animal on its toes are all of great influence from his point of view. Then as regards the carcase, " internal " characteristics which may be suspected from external signs are revealed in unmistakable fashion. The thickness of the belly, proportion of lean to fat, the texture of the fat, presence of seedy-cut, thickness of rind, and numerous other points claim our attention. When these desiderata are classified they fall naturally under two heads, namely, " breeding " defects and " feeding " defects.

Breeding Defects.—There are some twelve different pure breeds of pigs in these islands, each of more or less distinct type. These give rise to 132 first-crosses. Moreover, there are varying types within each breed, and selection for breed characteristics is not based on exact measurements. In addition, mongrel breeding is widespread. Consequently there is no need to stress the point that the curer's raw material is, to say the least, very heterogeneous in external conformation. In sharp contrast with this we find that our Continental rivals have chosen two breeds only, and work largely on the first-cross between them. The two breeds are, and have been for the last twenty years, continuously graded up by selection on commercial standards. We can obviously do little at home until we have set up similar machinery. Fortunately, one parent of the ideal first-cross is already known, and in the Large White breed we have material for producing the best sire for bacon purposes. Here we merely follow what has already been recognised not only by Denmark, but also by Sweden, Russia, Poland, Lithuania, Esthonia, and other competing countries. There are, however, several existing types of Large White in this country, and breeding centres for the production of ideal bacon sires are therefore an obvious necessity. With regard to the sow, there are four or five possible breeds which possess characteristics suitable for mating with the Large White boar for the production of bacon. Breeding centres are also required for these in order to concentrate on the most suitable types. In making these selections, due regard must be had to the economic possibilities of the sow. Such questions as prolificacy and rate of growth are naturally not of direct interest to the curer, but are of highest importance to the pig-feeder. Thus one well-known breed of sow which mates up well with the

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Large White often fails to produce the desirable size of litter, while another breed, also a good bacon parent, gives rise to slowly-growing offspring. Hence litter testing stations are needed for selection of the most economic breeds, strains, or individual parents.

FEEDING DEFECTS.—Under this heading one would mention three distinct defects which are of importance to the curer: the composition of the fat, the proportion of lean to fat, and the nature of the skin. There may be other defects in the finished pig which are associated with feeding, but these either influence the health of the animal, and are therefore outside the purview of this article, or they are of minor interest.

With regard to the composition of the fat, in an "ideal" animal fat should be produced entirely from starch or sugar by chemical synthesis. It is, however, a rather interesting possibility that such fat might be practically devoid of distinctive flavour. It is now well known that an excess of oil in the feed, over and above maintenance needs, is liable to be transferred to the fat depots, and is thus incorporated with synthesised fat. The admixture of extraneous oil modifies the composition and flavour of the fat in the direction which one would expect. It is thus possible that a small admixture of "foreign" oil or fat may confer a distinctive flavour on the natural fat of the animal. Thus may arise some justification for the attention which is called to milk-fed pork or beech-nut bacon, as being of characteristic properties.

When, however, the extent of this admixture is excessive, the composition of the fat is altered more or less profoundly. In the carcase, the fat may be soft and flabby, and the lard rendered from the animal is similarly affected. In the bacon, the softness of the fat makes it more easily liable to oxidation, so that rancidity sets in with greater or less rapidity. In hams, where the cured material is deliberately kept at an elevated temperature for prolonged periods, this liability to go rancid has full scope, and may influence very adversely the character of the hams.

One specific flavour which is the bugbear of the curer is that of fish, which may arise from the feeding of either fish meal, fish offal, or excess of cod-liver oil. Produce so fed is often unsaleable. In general, the influence of feeding on the quality of the produce is marked. A diversity of choice as regards feeding stuffs, and a lack of knowledge as to how they may best be combined, are the root causes of the trouble in this country. Where methods of feeding are standardised, as in Denmark, the composition of the fat is uniform in the produce.

The proportion of lean to fat is of paramount importance in bacon. Whilst strictly a feeding question, the influence of breeding and management must not be overlooked. Since some breeds or strains appear to have an exaggerated tendency to put on fat, the offspring derived therefrom must be specially watched in this respect. As regards management, several influences may contribute towards over-

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fatness. If growing pigs are allowed plenty of freedom they will not tend to fatten. However, such methods are akin to the out-of-date store period, and are now known to be uneconomic. Consequently, when pigs are shut up at an early age, and are housed so as to reduce their maintenance requirements, fattening is facilitated ; pigs so managed must be fed so as to grow bone and muscle rather than fat, and in particular, the necessary balance with respect to protein and lime in the ration must receive attention. As the pigs increase in size, it is customary to raise the proportion of carbohydrate in the ration ; should this be done too rapidly it will naturally stimulate fattening as opposed to growth. An old-fashioned idea in this connection was to miss one meal a week (usually on Sunday !) in order to encourage streakiness. There is no information available as to whether this expedient is effective except perhaps in an indirect way. Aligned with this is perhaps the other custom, that three small meals per day are better than two large ones, the latter being assumed to encourage fattening. More frequent meals, of course, enable a better utilisation of the food.

Pigs which spend a great portion of their post-weaning existence in the open air tend to develop through natural causes a tough, thick hide. This defect is not always given the attention it needs, and is easily corrected.

WEIGHTS.—The size of the pig required for curing has not yet been mentioned. Pigs below 140 lb. deadweight are useless for bacon. At the other end of the scale, the Wiltshire curer limits his requirements to 180 lb., whilst the Midland (ham) curer goes up to 210 lb. Beyond these limits a reduction in price is made. It is an extraordinary fact that despite the many official pronouncements on this subject, feeders still persist in sending pigs whose dressed weights exceed 240 lb. The excuse often offered is that pigs only begin to pay when they reach these weights. This idea is deeply rooted and very erroneous, but it is proverbial that custom dies hard. The other fault, of sending in pigs before they reach factory weights, is sometimes committed by those who specialise in pork pigs, and who have somehow missed the market at the end of the winter.

CONCLUSION.—Only a brief outline of this subject has been attempted, since it was felt that detailed discussion is not required by readers of this Journal. No doubt enough has been said to indicate the broad lines along which our pig industry will have to travel in the future, whether for self-defence, or in order to take full advantage of any Governmental assistance which may be forthcoming. The education of the farmer in this matter is long overdue, for there is much leeway to be made up. There is no fundamental reason why we should not produce all the pigs we need at home : we have the stock, the men, the land, and the knowledge ; all that is now wanted is something which will bring them into co-operative action.

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THE ELECTRIC STUNNING OF PIGS FROM THE STANDPOINT OF THE MEAT INDUSTRY AND ANIMAL PROTECTION.

By Dr. MAX MÜLLER.

Professor of Meat Inspection in the University of Munich.

In the Review, of September, 1928, of this Journal, I touched on the new electric stunning tests carried out by Weinberger and myself on the slaughter of swine. We had as one electrode for the conduction of the current, the iron trap, and put the second electrode in the form of a staff with a movable plate on the occiput of the subject. In this way a crushed fracture of the vertebra was sometimes produced at the contact of the electrode. This was interesting biologically, as it showed that under certain conditions a weak electric current like an electrospasm could produce an injury, if at the place of contact the antagonistic effect of groups of muscles produced too strong a simultaneous contraction. We have consequently abandoned this procedure, and have constructed tongs with an electrode at each end, and these have proved satisfactory for the stunning of pigs before bleeding. The head of the pig is so placed in the tongs that the brain lies directly between the two electrodes. It is better to place one electrode on the cheek, and the other over the opposite eye. As the skin of swine presents a great resistance to the electric current, the electrodes are provided with blunt teeth, between which india-rubber sponges are fixed. These serve to absorb a strong salt-water solution in order to overcome the resistance of the skin against the penetration of the current into the brain. These tongs render it quite possible to stun swine without a trap or trough. With the laying-on of the tongs on the head a general spasm of the muscles is produced, and the pig sinks down unconscious and remains so as long as the tongs remain in contact with the head.

This method of electrical stunning is also being carried out in England by an instrument (tongs) under the name of " S.R.V. Electrolethaler No. 2," made by the General Radiological and Surgical Apparatus Co., 204/6, Great Portland Street, London. As therefore in England this procedure of stunning has been adopted by the animal industry it proves that the procedure is quite adaptable for the purpose. Also in Germany this has caused a change in the method of stunning swine, and it has been adopted in other countries. In Germany, both in the public and private slaughter-houses, there is a revolutionary transformation in the passing over from the use of the captive bolt to the tongs. Here the slaughtermen and butchers ask for the introduction of electric stunning as soon as they have had the opportunity of witnessing the electrical method. In Munich for two and a-half years the slaughterers were allowed to use both the bolt and electricity, but the use of electric stunning gained much ground, and for two years now in Munich all pigs have been stunned with the electric tongs. The slaughterers appreciate the obvious advantages to be derived from this stunning by electricity.

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FIG. 2.—The pig-killing department of Munich Abattoir.
(Article by Dr. Max Müller, *page* 452)

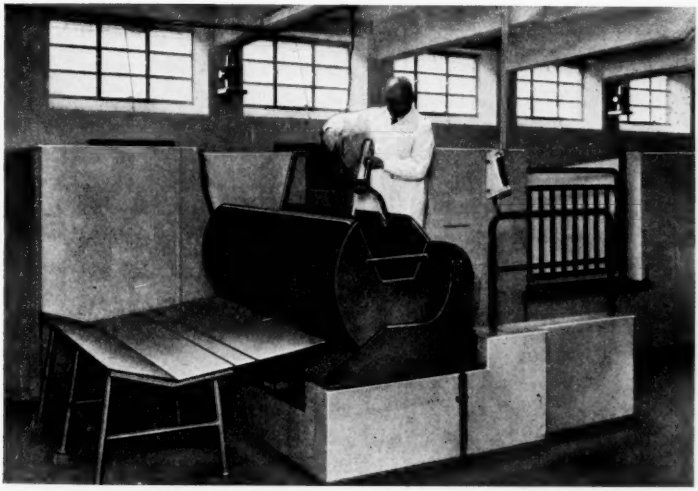

FIG. 3.—Demonstrating the electro-lethaler, the pig-trap in position.
(Article by Dr. Max Müller, *page* 452)

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Comparing the mechanical killer with electrical stunning, the slaughterers declare that the electrically-stunned animals can be much better bled out than the shot animals. (This has been corroborated in an exact scientific way by the researches of J. W. Edington and A. Elliott, *Veterinary Record*, 1931, p. 1303.) Electric stunning produces whiter and firmer flesh, and the bleeding out is more complete. The head and the brain are uninjured, the brain is not hæmorrhagic, and is free from embedded hairs, which makes the head more valuable. Especially is it the case that the meat is not " splashed," which is very prevalent in the shot animal. As a matter of fact, in the abattoir in Munich, since the introduction of electric slaughter, all objections to " splashed " carcases have disappeared. Electrically-stunned pigs not only yield more blood, but they bleed to death better. They lie quite peacefully whilst being bled, whilst the shot animal struggles violently whilst being bled. The slaughterers have found out that electric stunning is not difficult work. Where stunning is carried out in pens, and without the trap, it is a very quiet operation, whereas with the hammer the animal is often restless and alarmed. The stunning with the hammer is also rough and irritating to the animal from a humane standpoint.

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For the management of the abattoir, electrical stunning has the advantage that it is considerably cheaper than the mechanical killer ; as for the cost of shooting one pig, 200 or more pigs can be killed by electricity. The initial cost of the electric apparatus is repaid in a much shorter time than that of the mechanical killer. Electrical stunning, too, has the advantage that the animals need not be put into a trough or trap such as is necessary for the accurate use of the mechanical killer. It is also of physiological interest that after electrically-stunned animals, fractures of the vertebra and other bones have been found. They may occur if the current is too roughly applied, as it violently tetanises all the muscles, flexors and extensors, or if an animal is too tightly restrained (such as sometimes happens when a small pig falls low down into a large trap) whilst stunning.

Since the introduction of the tongs one million pigs have been slaughtered in Munich without any complaint from the trade. The biological mechanics of electrical slaughter is as follows : When the musculature of the body is electrically irritated through the nerves at the termination of the current an irritation arises at the kathode—the kath-electrotonus ; on the setting on of the current an irritation occurs at the anode, the stronger analectrotonus. The shocks follow each other so quickly that a relaxation of muscle between the electric shocks is no longer possible, and a muscle tetany arises, which I have designated electro-spasmus, in order to correct any false impression which may arise from the use of the word " tetany." As soon as all the muscular parts of the body, the musculature, the heart, and the muscularis of the vessels, are attacked the collective blood circulation is hindered. The prevention of the circulation of the blood in the brain brings about loss of consciousness and feeling. There is also a momentary generation of electrospasmus, as a proper electrical irritation of the whole nervous system, including the brain, from the moment of the occurrence of loss of con-

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sciousness and sensation. The general contraction of the muscles and musculature of the vessels causes a stasis of blood in the venous system, and after shutting off the current a good "bleeding" of the animal follows. (See experiments of S. A. Clark, W. Tweed and D. J. Anthony, *V. R.*, Nos. 7 and 14, Vol. XII, 1932.) The longer the animal is kept in the electrospastic state, the longer the state of unconsciousness after the cutting off of the current. On the other hand, the checking of the blood circulation and muscle tetany should not be continued too long because a severe blood stasis in the venous system in heart weakness, brought about by electric spasmus, has as its final *dénouement* a loosening of the cement substance of the capillary endothelium in the muscles, and so muscle hæmorrhages occur. Muscle hæmorrhages (splashing) in electric stunning are therefore due either to faulty stunning, in which the blood circulation is held up too long, to too high tension, or too strong current; especially if an injury to the contractile power of the heart has resulted. In general, five to ten or fifteen seconds is long enough to keep the animal in the electrospastic state in order to perform painless bleeding during the period of unconsciousness. In this way a very humane slaughter, which fulfils all the requirements of the animal protection societies, the meat trade, and the animal industry, can be carried out.

I have, with Mr. Weinberger, had the hope that this method would find a place in the Jewish ritual of slaughter. It is already used for calves, sheep, and other small animals, also for birds and fish. Although the procedure has not yet been adopted by the Rabbis, the Bavarian regulation has, however, stressed the standpoint that electric stunning is suitable for the Shechita because there is no injury to the brain or any other organ. The Bavarian regulation has been followed by a similar one in Switzerland and Norway, and on October 1st, 1930, a law was passed that *all* animals should be stunned before bleeding. Similar orders have also been drawn up for other German States, and the time is not far distant when a law for all Germany will be passed enacting that all animals must be stunned before bleeding. This is justifiable, and should be the aim of all animal protection organisations and civilised communities.

A PRELIMINARY NOTE ON THE USE OF THE ELECTRO-LETHALER FOR ANÆSTHETISING PIGS AND OTHER WILD AND TROUBLESOME PATIENTS.

By FREDERICK HOBDAY, C.M.G., F.R.C.V.S., F.R.S.E.

Principal, and Professor of Surgery and Anæsthetics, in the Royal Veterinary College, London.

Some two years ago my attention was drawn to the observations made by Professor Max Müller, of Munich, on the use of electricity applied with sufficient power only to render unconscious, without definitely destroying, the animals of the slaughter-house used for human food; and whilst on a visit to the Municipal Abattoir of Cologne, the veterinary inspectors very courteously allowed me to see the electro-lethaler in use.

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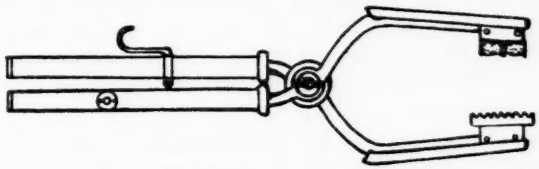
I was so impressed with its humanity and ease of application that I persuaded Messrs. Marsh & Baxter, whose bacon-curing factories are amongst the largest in Great Britain, to allow an installation, and the result has been so satisfactory that not only are the pigs rendered unconscious before the knife is used on the throat, but the calves and the sheep are also handled with equal efficiency and humanity.

Mr. Ernest Marsh, the managing director, being desirous to obtain scientific evidence as to its painlessness, deputed a committee, consisting of Professor Leonard Hill, M.D., F.R.S., late of the Medical Research Council; Professor W. Legge Symes, M.R.C.S., Professor of Physiology at the Royal Veterinary College, and myself, to investigate the matter scientifically, with particular reference to the question of humanity. With this object in view, in July last,



Tongs used for stunning pigs. Note control switch on handle, and hook for hanging tongs on wall when not in use.
(Illustration by courtesy of the General Radiological and Surgical Apparatus Co., Ltd.)

we made careful observations on a large number of pigs which were slaughtered for human food in the Brierley Hill Bacon Factory, and the following report was the result:

Report on the Pigs Killed for Food.

The pigs appeared to lose consciousness instantaneously as soon as the tongs were applied, the conjunctival reflex being abolished immediately. From ten to fifteen seconds appeared to be sufficient length of time in ordinary eight-score pigs, and twenty to thirty seconds for a large twenty-score sow or boar, in order to produce an unconsciousness lasting for approximately two minutes, which was more than a sufficient length of time for the body to pass through the hands of the " sticker," where we saw no evidence that any one of the seventy-five animals felt any pain. The whole procedure was practically noiseless. In no instance, either with the pigs or the sheep, did the animal show signs of fright or give evidence that they realised anything unusual was proceeding.

Use of this Method as an Anæsthetic for Operations.

Three large boars, each between three and four years old, and weighing about twenty-eight score, were castrated under the anæsthetic influence of the apparatus. One animal was vicious, but in no instance was there any difficulty experienced in fixing the tongs into position. In the first one the tongs were applied for one minute, and the operation was commenced. A deep and definite anæsthetic effect lasted for two minutes, but as the operation (torsion) was not yet completed, owing to some old adhesions being discovered, and the pig was commencing to open its eyes, the current was re-applied twice for about

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forty-five seconds each time until the operation was completed. This took eight minutes altogether. This was evidently too much, as the heart, after the third application, ceased to beat, and although artificial respiration was attempted, the animal could not be resuscitated.

In the other two instances the tongs were applied for forty-five seconds on the first occasion and for about thirty seconds on the next. The operations took seven and four and a-half minutes respectively, and in each case the pig got up two minutes later and quietly walked (unsteadily at first) back to another pen.

Its use as an anæsthetic is not unattended with risk to the patient, as Mr. Anthony, M.R.C.V.S., the chief veterinary official for Messrs. Marsh and Baxter, has observed, upon post-mortem examination of those killed for food, fractured bones in the carcases as the result of the violent muscular spasm which takes place when the current is applied. The fact, too, that in one instance death occurred from too long an application of the current, is an illustration of the risk in this direction. It is possible, though, that each of these accidents was due to inexperience in its use.

After the operations the pigs lay still for about two or three minutes, then looked around in a dazed manner and attempted unsteadily to get up. They were on their legs in about four minutes, and walked unsteadily at first, but in about five or ten minutes were practically recovered. The others made good recoveries.

In my opinion this method has a very valuable practical future in front of it, especially as an anæsthetic for the control of painless surgical operations on wild animals, birds, and even reptiles and fish, such as are sometimes necessary on the inmates of a zoological garden.

I have recently paid a visit to Professor Müller and Mr. Weinberger, in Munich, and they very kindly demonstrated its uses on large cattle, fowls, and fish. In each case the electro-lethaler acted effectively, and in each variety the animals (or birds, or fish) showed not the slightest fear or evidence of previous pain when subjected to the use of the instrument a second time. As this issue of THE VETERINARY JOURNAL is devoted solely to pigs, I will leave the description of the use of this method on cattle, fowls and fish to an article at a later date.

SALMONELLA AGGLUTININS IN THE SERA OF NORMAL SWINE.

By REGINALD LOVELL, M.Sc. (Vict.), M.R.C.V.S., D.V.S.M.
London School of Hygiene and Tropical Medicine.

IT is not a new observation that the blood serum of healthy normal pigs is capable of flocculating suspensions of various bacteria. Among the early records are those of Uhlenhuth *et al.* (1909), who found agglutinins for *Bact. suipestifer* in the sera of healthy swine, as well as in the sera of swine which had been slaughtered when ill with swine fever. Savage (1918) summarises his findings in a statement to the effect that agglutinins for the Salmonella group were fairly

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well developed in 40 to 50 per cent. of pigs tested. All of the twelve samples of pig sera examined by Kinloch, Smith, and Taylor (1926) agglutinated one or more of a series of Salmonella bacterial suspensions. The titres in this series varied from 1 in 50 to 1 in 100. Gibson (1930) included samples of normal pig serum in his experiments on normal agglutinins, and considered that the sera of ox, pig and horse gave consistently strong reactions with various bacterial suspensions, compared with the sera of certain other animal species. The sera of 202 normal healthy swine were examined by Lovell (1932) for agglutinins to several Salmonella bacterial suspensions. The suspensions were formalised broth cultures, and only the agglutinins for the " H " flagellar antigens were therefore apparent. Of the 202 samples, 190 gave reactions with one or more suspensions to a titre of 1 in 20 or over. Absorption tests revealed a specificity for the bacteria concerned. There seems to be no doubt that agglutinins for both " H " and " O " components may exist in normal swine sera. Further work by Gibson (1932) indicates this to be the case, and work by the author, which is as yet unpublished, would tend to confirm it.

It may therefore be accepted that the serum of normal healthy swine may agglutinate bacterial suspensions to a low titre. Such agglutinins may be for the " H " flagellar and the " O " somatic antigens of various members of the Salmonella group. Judged by absorption tests, these agglutinins appear to be specific. Their significance is puzzling. That they are due to previous infection with members of the Salmonella group does not fit in with the failure of many authors to isolate Salmonella bacteria from the intestinal contents and tissues of normal swine. The point of practical importance is that the presence of such agglutinins is not in itself evidence of infection with a member of the Salmonella group.

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STUDIES ON NUTRITIONAL ANÆMIA IN SUCKLING PIGS.

By VALD. ADSERSEN, V.S.

Chief of Department, State Veterinary Serum Laboratory, Copenhagen.

In the earlier literature there are several reports on blood findings in swine, mentioning now and then that strikingly low hæmoglobin values are obtained in pigs at the age of three to four weeks. It is only in recent years, however, that various authors have demonstrated that when suckling pigs, with no admittance to the open, are nourished exclusively with the mother's milk, they have quite constantly a marked degree of anæmia that is most pronounced at the age of three weeks. As early as 1923–24, McGowan and Crichton,[1] of the Rowet Research

Institute, Aberdeen, demonstrated that this anæmic condition is of great importance as a contributory cause of the sudden death so often observed in pigs of three to four weeks, in which the most conspicuous autopsy findings are a marked dilatation of the heart, resulting in various phenomena of stasis. This anæmia is further an important factor in the stuntedness that begins to develop at that age in pigs which had been thriving normally in the first weeks of life, resulting sometimes in a more or less pronounced retardation of the development of the pigs, and sometimes in fatal malnutrition of the pigs, often associated with secondary infection of various nature. In addition, McGowan and Crichton demonstrated that this stuntedness and mortality may be checked by supplying the pigs with iron oxide.

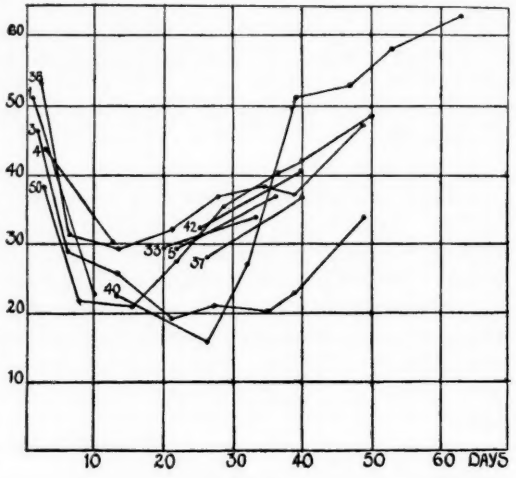

FIG. 1.

Amongst American authors, Hart and his associates[2] (1929) and Craig[3] (1930) have published some extensive studies on anæmia in suckling pigs, which disease is said to be a very essential cause of malnutrition and death among suckling pigs in the United States of America. By giving iron preparations to the pigs it was possible to prevent the development of anæmia, whereas addition of iron salts to the feed of the sows during gestation and lactation did not prevent the appearance of anæmia in the suckling pigs. In the last couple of years I have been engaged, partly in co-operation with J. E. S. Jörgensen, V.S., with studies on anæmia in suckling pigs, its ætiological significance as to the mortality amongst suckling pigs, and its prevention; and as the editor of this Journal has asked me for a contribution to the special issue on diseases in swine, I am pleased to meet this request with a brief survey of these investigations.

In co-operation with Jörgensen[4] I have made systematic determinations of the hæmoglobin content of the blood, about once a week through several months, on all the suckling pigs in a healthy swine stock belonging to a practising veterinary surgeon (Dr. Möller, Höng). The hæmoglobin values obtained in September and November, 1930, are presented graphically in Fig. 1. The examinations were repeated in February to April, 1931, giving practically the same results. In this graph the age of each litter is plotted along the axis of abscissæ, while the

hæmoglobin values (Sahli) are plotted along the axis ordinates. The average of the hæmoglobin values obtained in the pigs of each litter is marked by a point, and the successive averages for each litter are joined into curves representing the respective litters.

It would be going too far here to enter into the details of these determinations, but summarising the results we found, in keeping with the findings of other authors,[1] that the hæmoglobin values in new-born pigs correspond to about 8 to 10 gm. per 100 c.c. blood[2]; that within the first two to three weeks of life there is a marked fall in the hæmoglobin content of the blood down to one-third, or even less, of the hæmoglobin value at birth; and (3) that in the following weeks there

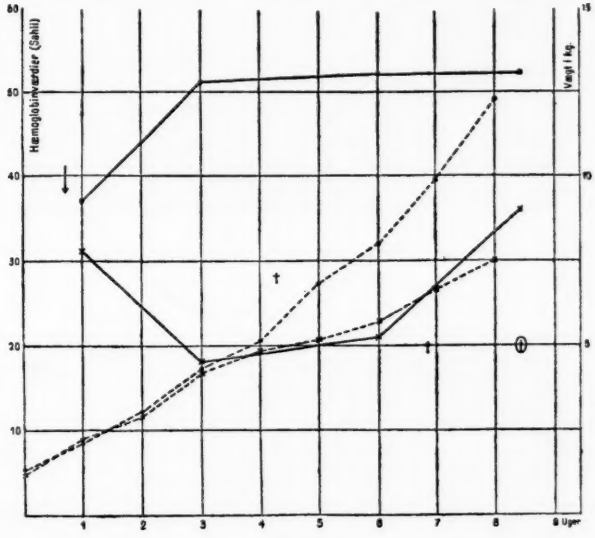

FIG. 2.

is a demonstrable, more or less rapid, increase in the hæmoglobin content of the blood, the intensity of this rise being on the whole dependent upon the extent to which the pigs have access to, or desire for, other food besides the milk of the dam.

In December, 1930, I commenced my inquiries into the prevention of this anæmia and its significance as a factor in the malnutrition and mortality of suckling pigs.[5] The experiments were carried out on a large stock in which the pigs were healthy at birth, and thrived normally till they were three to four weeks old. At this age a large part of the pigs had diarrhœa, many died, and the rest were markedly stunted. The preceding spring several suckling pigs of this stock were said to have died of pneumonia; after this all the suckling pigs of the stock were treated with swine Pasteurella preparations immediately after birth. During

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the following summer the mortality had been low; and then it increased again considerably during the last months of the year.

The investigations carried out on this stock* comprise all the pigs born in the stock from December 18th, 1930, to February 3rd, 1932: altogether 91 litters, totalling 907 pigs born alive. One hundred and nineteen of these pigs died within the first days after birth (most of them smothered to death under the sow). Of the remaining 788 pigs, distributed in 91 litters, experiments were made as to the prevention of the anæmia. The results, concerning the mortality and the weight increase of the animals, are given in Tables 1 to 4. As will be noticed in

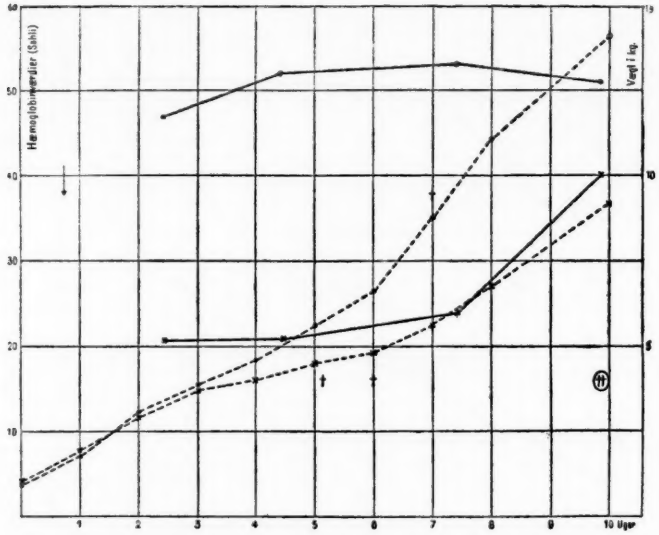

FIG. 3.

these tables, the experimental litters are divided into groups, as the experiments are carried out in different ways.

On the litters born during the period December, 1930, to March, 1931, the experiments were made as follows: From the age of one week till they were weaned, half of the pigs of twelve litters were given daily one teaspoonful of a 2.5 per cent. solution of ferrous sulphate (commercial), while the other half of the pigs of these twelve litters served as controls. All the pigs of these litters were vaccinated with swine Pasteurella preparations. In seven other litters

* On this stock extensive feed experiments are carried out under the direction of Professor Johs. Jespersen, the Royal Veterinary and Agricultural College, who has been kind enough to give me valuable assistance, placing his personnel at my disposal in weighing and treating the pigs.

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FIG. 4.—Actual application of the electro-lethaler.

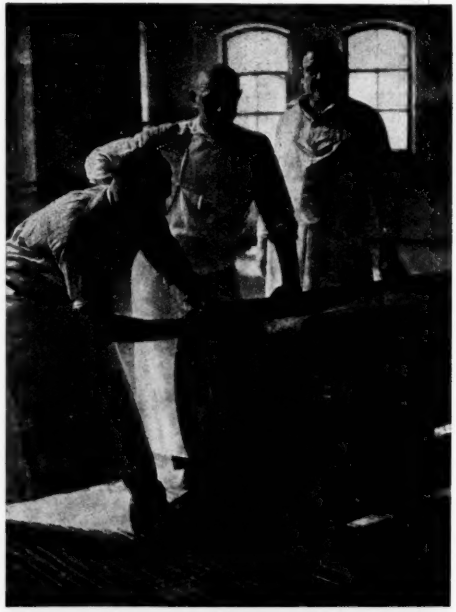

FIG. 5.—Ejecting the carcase.

(Article by Dr. Max Müller, *page* 452)

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half the pigs were vaccinated, and none of the pigs were treated with ferrous sulphate. Of the litters born in April, 1931, half the pigs of six litters were treated with ferrous sulphate as above, while the other half of the pigs of these litters served as controls. In three other litters the pigs were not treated with ferrous sulphate, and none of the pigs of all nine litters was vaccinated. Of the litters born in May and in the beginning of June, 1931, half the pigs of three litters were treated with ferrous sulphate, while the other half served as controls. Five litters were not treated at all, but were allowed to run about in a grass field.

All the pigs are weighed at birth, and then every week till they are eight weeks old. Further, at intervals of about two weeks I have made three to four hæmoglobin determinations on every pig.

TABLE I.

21 LITTERS—170 PIGS.

(*Half the pigs of each litter treated with ferrous sulphate.*)

Eighty-six Treated Pigs.—Eighty-two alive at the age of eight weeks. Average weight at birth (73*), 1.31 kg. Average weight eight weeks old (69*), 14.64 kg.

Eighty-four control pigs.—Sixty-five alive at the age of eight weeks. Average weight at birth (71*), 1.29 kg.; average weight eight weeks old (57*), 11.10 kg.

10 LITTERS—81 PIGS.

(*None of the pigs treated with ferrous sulphate.*)

Forty-five alive at the age of eight weeks. Average weight at birth, 1.28 kg. average weight eight weeks old, 11.38 kg.

5 LITTERS—40 PIGS.

(*Pigs admitted to the open.*)

Thirty-five alive at the age of eight weeks. Average weight at birth, 1.32 kg.; average weight at eight weeks old (32†), 15.29 kg.

The influence of the ferrous sulphate treatment upon the weight increase of the pigs, and upon the mortality amongst the pigs is evident from Tables I and II.

As the vaccination proved to be without influence upon the weight increase (as well as upon the mortality), the above-mentioned litters entered in Table I are made up into three groups: (1) Litters in which half of the pigs are treated with ferrous sulphate; (2) litters in which none of the pigs are treated with ferrous sulphate; (3) litters admitted to the open. As shown in this table, the average weight of the pigs at birth was practically the same in all three groups (in the first group two litters that are weighed the first time at an age of one week and two litters weighed the last time at the age of seven weeks, are not included in the calculation of the average weight). But at the age of eight weeks the average weight of pigs treated with ferrous sulphate and of the pigs allowed

* Number of pigs weighed (*see* the text).

† Three pigs not weighed at the age of eight weeks.

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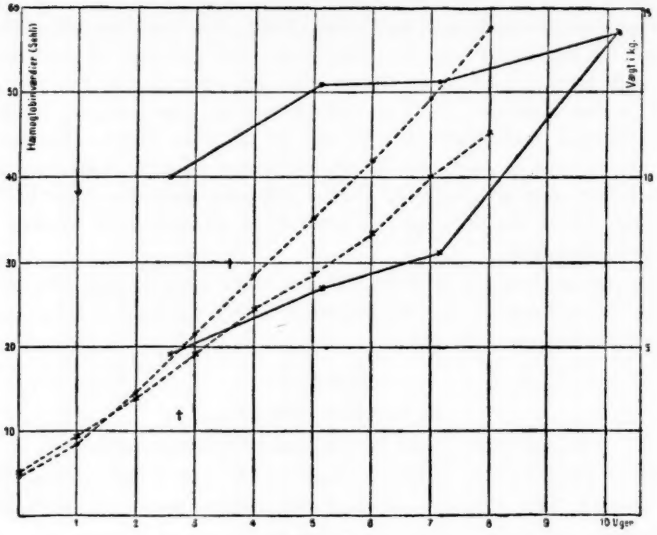

FIG. 4.

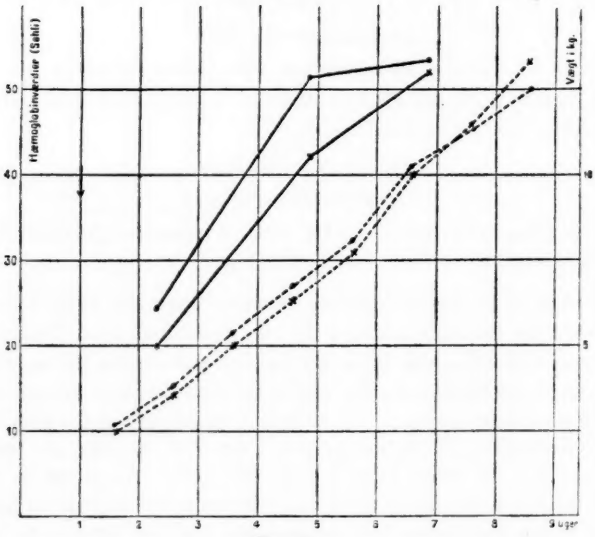

FIG. 5.

EXPLANATION OF FIGS. 1 TO 5.

In each figure the arrow indicates when the administration of ferrous sulphate begins. The average hæmoglobin values (Sahli) obtained in treated and non-treated pigs are given respectively by dots and +, connected by straight lines. Correspondingly, the average weight obtained at each weighing of treated and non-treated pigs is put down as dots and + respectively, and these are connected by broken lines. + means the death of one pig, amongst the treated animals when it is placed in the upper part of the figure, and amongst the non-treated pigs when placed below. Framing of the cross signifies that the pig was killed.

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to run about in the open was more than 30 per cent. above the average weight of the pigs which were not treated with iron and not admitted to the open.*

To illustrate the relation between the hæmoglobin level and the weight increase, Figs. 2–5 present graphically the average hæmoglobin values obtained, and the average weights registered at the weekly weighings of the treated animals and the controls in four different litters. In the untreated pigs the variations of the hæmoglobin values correspond on the whole very well to the form of the hæmoglobin curves in Fig. 1. The iron-treated pigs, on the other hand, show, as was to be expected, a high hæmoglobin level shortly after the treatment is instituted, and the hæmoglobin values keep practically constant at this level throughout the lactation. Corresponding to this, all the iron-treated pigs, with the exception of one litter, show a considerably greater increase in weight than do the control animals, and this difference of weight increase is demonstrable from the time when the hæmoglobin value in the untreated pigs has reached its minimum, *i.e.*, at the age of three weeks. Deviations from this rule are encountered only in one litter, presented graphically in Fig. 5. In the iron-treated animals of this litter the effect of the iron unaccountably failed to appear till late, while to the contrary, the rise of the hæmoglobin value in the non-treated pigs made its appearance unusually early and abruptly, so that throughout the lactation there was but a slight difference in the hæmoglobin content of the blood in iron-treated pigs and non-treated, and accordingly the weight curves were practically parallel.

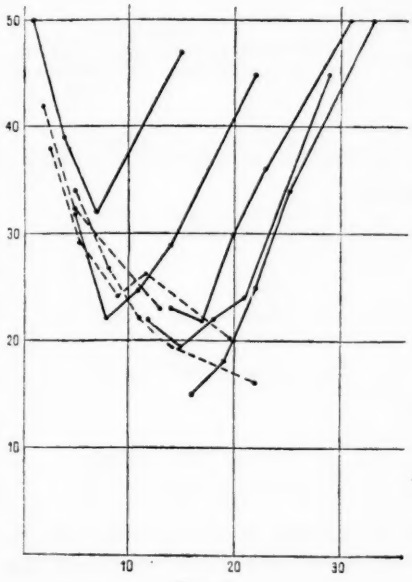

FIG. 6.

The hæmoglobin values obtained in the pigs which were admitted to the open are presented graphically in Fig. 6: the hæmoglobin values being determined the first time each of the five litters was allowed to run about in the open, and afterwards at short intervals. The curves show that the access to rooting and

* In the feeding experiments carried out under the direction of Professor Johs. Jespersen on sows of the stock here concerned, it has been shown that differences in the composition of the feed for the sows have had some influence on the weight increase of the pigs. In grouping the experimental litters for the experiments here reported, however, care has been taken that the pigs of sows on different diets are distributed equally in the different groups, so that the influence from the feed of the sows is of no significance as to the estimation of the effect of iron treatment upon the weight increase.

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intake of vegetable matter brings about a rapid rise in the hæmoglobin content of the blood. The dotted lines show the synchronous hæmoglobin values in three litters that were not admitted to the open ; in these three litters the hæmoglobin curves take the usual course (*see* Fig. 1).

It is to be mentioned, however, that the examinations continued in the summer of 1931 have shown that it is not a rule to be reckoned with that when pigs are admitted to the open immediately or shortly after birth, the hæmoglobin value will always rise so rapidly and to such a height as found in the five litters here mentioned. The access to rooting, however, will always prevent the development of marked anæmia.

TABLE II.

Time of birth	Number of litters and pigs. Treatment.	Dead or killed. In suckling period or shortly after.	Dead or killed. Later (third to fifth months of life).
	12 *litters*—99 *pigs* (all vaccinated)		
Born in December, 1930, to March, 1931	50 treated with ferrous sulph. ...	... 3 dead	3 dead
	49 control pigs...	... 17 dead, 5 killed	3 dead, 1 killed
	7 *litters*—60 *pigs*. (not treated with ferrous sulphate)		
	30 vaccinated	... 14 dead, 3 killed	3 killed
	30 not vaccinated	... 15 dead, 2 killed	
	6 *litters*—45 *pigs* (not vaccinated)		
Born in April, 1931	23 treated with ferrous sulphate ...	... 3 killed	
	22 control pigs...	... 4 dead, 2 killed	2 dead
	3 *litters*—21 *pigs* (no ferrous sulphate)		
	21 not vaccinated	... 5 dead, 3 killed	1 dead
	3 *litters*—26 *pigs* (not admitted outdoors)		
Born in May to June, 1931	13 treated with ferrous sulphate ...	...	
	13 control pigs...	... 3 dead, 2 killed	2 dead
	5 *litters*—40 *pigs*		
	40 admitted to outdoor conditions ...	... 3* died, 2† killed	

The influence of iron treatment upon the mortality is evident from Table II. As the anæmia in suckling pigs and its sequelæ are associated with the sucking period and the time immediately after, it is particularly the mortality within this period that is of interest here, and for this reason it is entered separately in the first column. For the sake of completeness, the number of pigs that died or were killed later on (in the third to fifth month of life) are entered in the second column, but the following remarks apply exclusively to the dead or killed pigs entered in the first column.

Table II shows that only a very few of the pigs that were treated with ferrous sulphate, or admitted to the open, have died or are killed, whereas a very large number of the non-iron-treated pigs died or were killed (about 30 to 60 per cent. in the various groups). The pigs which are killed are the ones which have failed

* Two pigs died at the age of four to eight days respectively before they were admitted to the open ; one died at the age of sixteen days from exhaustion under blood letting for hæmoglobin determination.

† Both pigs trampled down by a horse while staying outdoors.

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for several weeks to gain in weight, or such as are even losing weight. The table further shows that vaccination with swine Pasteurella preparations has had no influence on the mortality, and that the mortality in the non-treated animals

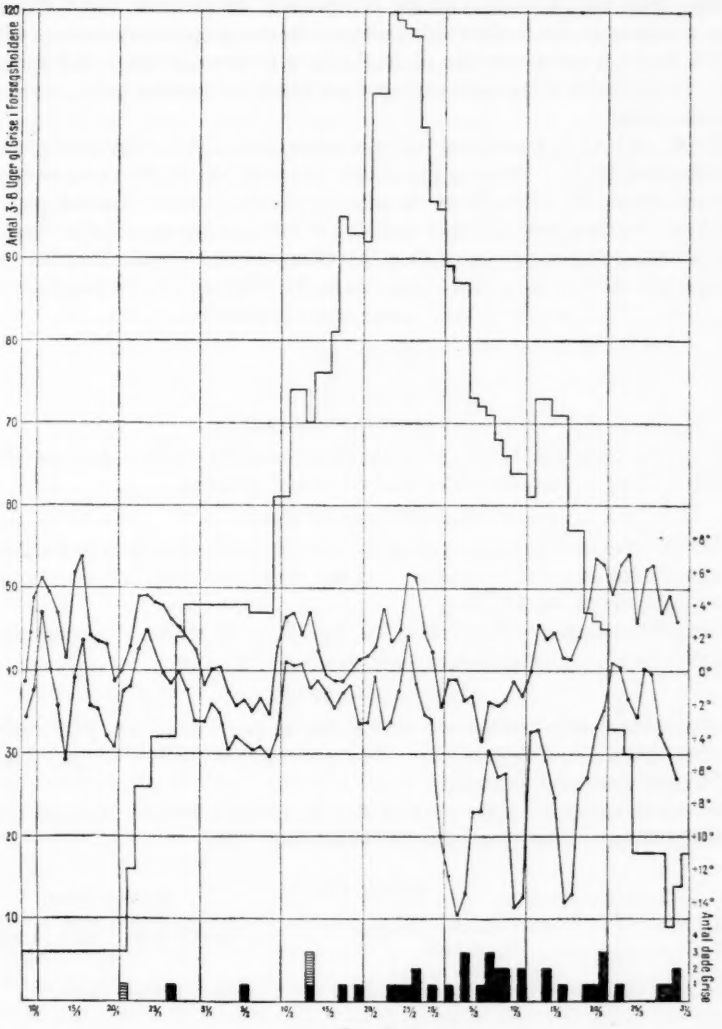

FIG. 7.

has been the highest amongst the pigs born in the winter months proper, December to March. The seasonal variations in the mortality are no doubt due to various contributory factors. From Fig. 7 it appears as if cold is a factor of some

significance in this respect. In Fig. 7 the upper dentate line gives for each day the number of three to eight weeks pigs alive out of the litters born from December to March, whereas the black columns at the bottom give the number of pigs of these litters that have died during this period. In addition, Fig. 7 shows the daily variations in the outdoor minimum-maximum temperature, and, as will be noticed, that the great majority of deaths have occurred in some cold period in which the minimum temperature was always below the freezing point, and sometimes far below.

Finally, it is to be mentioned that the mortality is apt to vary greatly within the individual litters. In some litters, all, or nearly all, of the non-iron-treated pigs died, whereas in other litters the mortality of the non-iron-treated pigs was quite low. Various facts, which it would take too long here to enter into, suggest that individual properties—possibly of hereditary nature— play a decisive *rôle* in the question whether the period of anæmia in the offspring is to be relatively easy to get over, or if it is to be of fatal consequence to the pigs.

TABLE III.

17 LITTERS—170 PIGS.

(*Pigs admitted to the open.*)

One hundred and sixty-two alive at the age of eight weeks. Average weight at birth, 1.26 kg.; average weight eight weeks old, 12.96 kg.

23 LITTERS—186 PIGS.

One hundred and forty-one pigs with access to earth or to iron preparations: 128 alive at the age of eight weeks. Average weight at birth, 1.33 kg.; average weight eight weeks old, 14.79 kg.

Forty-five controls: 39 alive at the age of eight weeks. Average weight at birth, 1.26 kg.; average weight eight weeks old, 12.68 kg.

15 LITTERS—141 PIGS.

One hundred and twenty-four with access to earth or to iron preparations: 120 alive at the age of eight weeks. Average weight at birth, 1.22 kg.; average weight eight weeks old, 12.96 kg.

Seventeen controls: eight alive at the age of eight weeks. Average weight at birth, 1.35 kg.; average weight eight weeks' old, 7.61.

TABLE IV.

Time of birth.	Number of litters and pigs. Treatment.	Dead or killed. In suckling period or shortly after.	Dead or killed. Later (third to fifth months of life).
June to August, 1931	*17 litters—170 pigs*		
	170 admitted to outdoor conditions... ...	3 dead, 1 killed	8 dead
September to November, 1931	*23 litters—186 pigs*		
	141 with access to earth or to iron preparation	15 dead, 1 killed	3 dead
	45 control pigs	9 dead, 5 killed	1 dead
December, 1931, to February, 1932	*15 litters—141 pigs*		
	124 with access to earth or to iron preparation	4 dead, 4 killed	1 dead
	17 control pigs	13 dead	

During the summer of 1931, all the litters born before September—altogether 17 litters, totalling 170 pigs—were allowed to run about in a grass field, just like the five litters that were born in the last part of May and beginning of June. As already mentioned above, the development of a marked anæmia is prevented in this way, and accordingly these litters show a very low death-rate, as is evident from Table IV. In the case of these seventeen litters, however, it took on an average longer time before the decrease of hæmoglobin value—varying in degree, but present in all the pigs—was balanced as effectively as in the aforementioned five litters. In the latter, as shown in Fig. 6, the fall of the hæmoglobin value was balanced very rapidly, possibly owing in part to particularly favourable climatic conditions at that particular time of the year. In keeping with this, the weight increase in the seventeen litters (*see* Table III) was not so satisfactory as in the five litters and in the aforementioned pigs treated with ferrous sulphate, yet it was considerably greater than in the pigs which had not been treated with ferrous sulphate during the winter and spring.

It is a very circumstantial and therefore almost impracticable measure, at any rate in large stocks of swine, daily to give each pig a dose of ferrous sulphate solution. Therefore at the time of the autumn when the summer pen with its free access to the open was no longer serviceable, a series of experiments were instituted in order, if possible, to decide how the iron required by the pigs could be supplied most easily and most satisfactorily when the daily treatment of each pig separately was to be avoided. These experiments comprised 38 litters, with a total of 327 pigs, and they were carried through as follows :

Four litters (36 pigs) had, from the age of one week, the opportunity to root and take in plough earth, half a shovelful being placed in the pen every day. From three additional litters, half the pigs (10) were placed for one to one and a-half hours daily in a pen with plough earth, while the other half of these litters (11 pigs) had no access to take in plough earth.

Four litters (38 pigs) had, from the age of one week, access to take in barley groats with an addition of ferrous sulphate (commercial)—one teaspoonful to the daily supply of groats—a portion that was never eaten up, especially to begin with. In two additional litters only half the pigs (13) had access for one to one and a-half hours daily to eat such groats with iron added, while the other half (11 pigs) served as controls.

Two litters (15 pigs) had, from the age of one week, access to milk with ferrous sulphate (commercial)—one teaspoonful to 1,000 c.c. In two additional litters only half the pigs (10) had access for one to one and a-half hours daily to such iron-containing milk, while the other half (11 pigs) served as controls.

Seventeen litters (143 pigs) had, from the age of one week, an opportunity to lick a solution of varying composition that was applied to the udder of the sow. This method is suggested by Hamilton and co-workers.[6]

The solutions were composed as follows : 1,000 c.c. of a mixture of equal parts of water and corn syrup is used for the respective solution of 12.5 gm. cupric

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sulphate + 87.5 gm. ferric citrate (used on 4 sows, 36 pigs) ; 100 gm. ferric citrate (used on 4 sows, 33 pigs) ; 100 gm. ferrous sulphate (commercial) (used on 4 sows, 35 pigs) ; 100 gm. ferrous sulphate (chem. pure) (used on 5 sows, 39 pigs) ; (controls with no access whatever to intake of iron : 4 litters, 29 pigs).

It would take too much space to give a detailed survey of the results obtained in the different groups as to hæmoglobin values, weight increase, and mortality ; but the total results of the experiments concerning the weight increase and mortality are given in Tables III and IV, where the animals are divided into two groups, comprising respectively the pigs born in September to November, 1931, and the pigs born in December, 1931, to February, 1932. From Table III it will be noticed that the pigs with access to intake of earth or iron preparations, and the control animals as to the weight increase, show a similar, although hardly so pronounced, difference as was demonstrated in the experiments carried out in the first part of the year.

Table IV shows that after the admittance to outdoor conditions had ceased, the mortality of the control animals was high, as in the first months of the year. But the total mortality in the different groups of the other pigs is considerably lower than the mortality in the control groups. Further, as will be noticed, the death-rate is lowest amongst the pigs born in the period December to February. The explanation of this is given below. Amongst the easily practicable methods here tried out for prevention of anæmia, at least of its severe degrees, the earth supply turned out to be the most effective. The little suckling pigs began at once to root in the earth and eat it, and the result was that amongst the forty-six pigs included in this group not even one died.

Addition of ferrous sulphate to groats proved somewhat less effective, the pigs being less inclined to seek this source of iron, especially at first, and this fact naturally resulted in the development of marked anæmia in some of the pigs. In this group, comprising fifty-one pigs, three died, while two had to be killed.

Milk with addition of ferrous sulphate was found to be even less attractive to the pigs. In this respect, however, the various litters and the individual pigs showed a good deal of difference, yet the result was that a number of the pigs of these litters were markedly anæmic. In this group, comprising twenty-five pigs, four died.

As to the application of syrupy solutions of various iron and copper preparations to the udder of the sow, there was no distinct difference in the effectivity of the four solutions employed. The solutions were smeared on the udder of the lactating sow with a brush once a day to begin with. It was soon found, however, that the amount of iron supplied in this way was not sufficient, as in fifty-eight pigs of sows having one application a day, eleven died. Then the respective solutions were smeared on the udder three times daily, and in the offspring of the sows under this treatment—a total of eighty-five pigs—only one died, while two had to be killed. All the pigs having access to milk with addition of ferrous sulphate,

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and all the pigs of sows having iron-containing solutions smeared on the udder once a day were born during the period September to November. The particularly large mortality amongst these pigs explains the great difference in the death-rate amongst treated pigs born during this period, and amongst treated pigs born in the following period, December to February (Table IV).

The experimental results here reported illustrate strikingly the significance of nutritional anæmia in suckling pigs as a weighty factor in the mortality of the pigs in the sucking period. The question then arises whether the pigs, dead or killed, have succumbed as a direct result of the anæmia, and perhaps debility of other origin, or whether the anæmia has made the pigs more susceptible to specific or accidental infections. To throw some light on this question, autopsy and bacteriological examinations have been carried out on all the dead or killed pigs. Here mention will be made only of the pigs that died or were killed during the lactation period and subsequent weeks, as most likely the anæmia has been of no particular ætiological significance in the cases of death (and killing) occurring later on.

As to the symptoms observed in these animals, it may be stated briefly that sudden death has occurred only in a very few cases. In the great majority of the cases death did not come till the pigs had for some time been very pale and weak, unhealthy, and often short of breath. Many of the pigs have had more or less severe diarrhœa, and in those that have been ill for some time the skin has become mottled and covered in part with crusts ; a good many of them have been emaciated and looking miserable. Autopsy has revealed almost constantly a more or less pronounced degree of dilatation of the heart, and degeneration of the myocardium, associated with stasis phenomena (especially in the liver).

In 74 out of 146 dead or killed pigs on which autopsy was made, changes of this kind were the only ones demonstrable. In the remaining cases, 23 showed more or less pronounced enteritis (of croupous character in three cases) ; pneumonia was found in 20 cases, pleurisy and pericarditis in seven, hæmorrhage and traumatic injuries in six, peritonitis in four, necrosis of various organs in three, pyæmia in two, hæmopericardium in two, hæmorrhagic diathesis in one, arthritis in one, tenosynovitis in one, mitral endocarditis in one, and abscess of the spermatic cord in one.

Bacteriological examination gave negative results in 89 out of the 146 pigs. In the cases of pneumonia the bacterial findings varied greatly (streptococci, staphylococci, pyogenes and Pasteurella bacteria, colon and Protheus bacilli). Further, diplococcus sepsis is demonstrated in four cases, colon sepsis in two, infection with necrosis bacilli in four, streptococcus pyæmia in one, pyogenous pyæmia in one, localised diplococcus or streptococcus infection in five ; and, finally, various forms of bacteria (colon bacilli, Protheus bacilli, streptococci, staphylococci) have been demonstrated, mostly very few in number, in 22 cases.

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This very summary survey shows that on the whole the autopsy findings and the bacteriological findings have been very variegated. This holds good, however, not only of the total material: it applies also to the individual litters in which a considerable number of the pigs have died. In these litters the findings have not presented an aggregation of uniform phenomena, anatomical or bacteriological, but a great variety of abnormal conditions also in the individual litters. Thus there will be no substantial evidence in support of the view that in this stock, or in its individual litters, the mortality of the pigs might be attributable to some definite infection. To the contrary, in the course of the one and a-half years these investigations have been going on, the dead pigs of this stock alone have given findings sufficient for practically all the pathologic-anatomical and bacteriological diagnoses that are made fairly frequently on examination of dead suckling pigs. Further, quite parallel findings have been obtained in other stocks in which we have had the opportunity to examine a fairly large number of dead suckling pigs. Thus there can be no doubt that the mortality of suckling pigs is ascribable to specific infection only exceptionally, if at all; whereas the insufficient resistance of the animals is quite the decisive factor. This lack of resistance *per se* may be the cause of death most frequently through impairment of the heart; or the lowered resistance may give rise to invasion of micro-organisms present in the surroundings of the pigs or vegetating on the mucous membranes, whereas the same micro-organisms are of no pathogenic significance for animals with normal resistance.

As to the cause of deficient resistance in the suckling pigs, there is undoubtedly a number of different factors to be taken into consideration (in a previous paper[7] I have pointed out the significance of the proper feeding of the sows during the gestation). Amongst these factors the nutritional anæmia is certainly of rather great importance. Many observations from practice have established, however, that the anæmic condition which develops in all suckling pigs without access to the open or to intake of iron preparations, is not necessarily of fatal consequence to the animals. As yet it is by no means clear what are the circumstances or the combination of causes that make the animals unable to pull through the anæmic period without therapeutic measures. But, as mentioned already, various findings suggest that individual, possibly hereditary, properties of the breeding animals are of essential, perhaps decisive, importance in this respect.

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NEWER INVESTIGATIONS ON THE HISTOPATHOLOGY OF HOG CHOLERA.*

By PROFESSOR DR. OSKAR SIEFRIED,

Director of the Institute of Animal Pathology of the University of Munich, Germany.

OUR histological investigation of a large number of acute hog cholera cases reveals two new facts which demand consideration with regard to the character and the post-mortem diagnosis of this disease.

(1) Central Nervous System.

A more or less marked encephalomyelitis and meningitis is found in a majority of cases of virus induced and spontaneous hog cholera. This hog cholera encephalitis is characterised by a varying amount of vascular and perivascular infiltration with small lymphocytes, mononuclear elements, a few plasma cells, and occasionally a few eosinophilic leucocytes. Certain gliacells show a proliferation surrounding infiltrated vessels, forming small nodules or more diffuse foci. Satellitism, and in a few instances true neuronophagia, have been observed. Both microglia and macroglia participate in this process. There is a special distribution of the encephalitic reaction in the central nervous system.

In nearly all parts of the brain and spinal cord degenerative changes of the nerve cells are encountered. Demyelinisation has been observed, especially in the spinal cord. Specific inclusion bodies in the nerve cells are absent. In a number of cases microscopic and macroscopic hæmorrhages are present in the brain, spinal cord, and meninges. These lesions have been found in varying degrees in swine infected with four different strains of hog cholera virus, and also in a number of spontaneous hog cholera cases. These central nervous system lesions are considered the anatomical substratum for the various nervous symptoms frequently associated with this disease.

(2) Vascular System.

The histological study of various organs shows that the hog cholera virus leads rather regularly to more or less pronounced lesions after entering the blood stream, particularly in capillaries, but also in small arteries and veins. Larger blood vessels are less frequently involved. These lesions consist of swelling, proliferation, and multiplication of endothelial cells, and retrogressive changes of these structures, including the remaining parts of the blood-vessel walls. Sometimes complete hyalinisation and necrosis of blood-vessel walls are found. The occurrence, character, and degree of severity of these blood-vessel lesions vary in different organs. They seem to be most pronounced in the lymph-nodes, spleen and kidneys, while in the central nervous system, liver, intestinal tract, skin and other organs, they are less noticeable. We believe that they are a principal feature in the histopathology of this disease because the hæmorrhages

* On request of the Editors.

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and progressive perivascular necrosis in the various organs result primarily from the vascular lesions. However, it has to be admitted that hæmorrhages may be present as a result of diapedesis in the absence of the described blood vessel lesions. These findings offer a satisfactory explanation for the characteristic localisation of the hæmorrhages in the lymph-node parenchyma. In the spleen the blood-vessel lesions are responsible for the hæmorrhagic and anæmic infarcts frequently associated with hog cholera. Other tissue changes in the various organs are mainly the immediate result of the blood-vessel lesions described above, and of the more or less pronounced hæmorrhages.

It should be noted that the lesions in hog cholera are not directly dependent upon the length of the disease. Furthermore, there are no fundamental differences between the lesions in pure virus induced hog cholera cases and those in cases associated with secondarily invading bacteria. However, we have the impression that the presence of *B. suipestifer*, *B. pyocyaneus* and bipolar bacteria aggravate the hæmorrhages and the degree of necrosis. Also the virulence of the virus seems to influence the process. In acute cases degeneration of the blood-vessel walls is prevalent, while in prolonged cases the proliferative character of the endothelial lesions is more evident.

In independent work carried on simultaneously with our own, Dide, Roehrer, Eberbeck, and Bel found the same type of encephalitis in acute hog cholera, and in addition Roehrer described the same blood-vessel lesions in the lymph-nodes and other organs. Similar lesions were probably first seen by Proescher and co-workers.

With regard to the practical application of these findings, the hog cholera encephalitis is of only limited value for the post-mortem diagnosis, because it is present in only 60 per cent. to 80 per cent. of acute hog cholera cases. In addition, it is doubtful whether this encephalitis is characteristic for hog cholera. In fact we feel that the blood-vessel lesions are of greater value for post-mortem diagnosis because they are almost invariably present. In our hands they, together with other lesions, especially in the lymph-nodes and spleen, were very helpful in establishing a diagnosis in a number of questionable hog cholera cases. Further investigations will show whether or not they are strongly diagnostic for this disease. Complete details on this work carried out in the Rockefeller Institute for Medical Research, Department of Animal and Plant Pathology, Princeton, N.J., in collaboration with Dr. C. B. Cain, is published in the *Journal of Experimental Medicine*, with a number of histological pictures (*see* references).

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Clinical Articles

Some Clinical Notes on Pig Diseases.

By R. HUDSON, F.R.C.V.S.
Retford.

Intestinal Obstruction Caused by Straw in Suckling Pigs.

THREE or four young pigs about two to three weeks old had died during the course of a few days, and as there appeared to be no reason for their deaths, I was called in. There was nothing abnormal in outward appearance, the dead pigs being of good colour, and the living pigs were lively and in good health. On opening the intestines I found them packed with chewn wheat straw for a considerable distance, and it had undoubtedly caused their death. The baled straw bedding was removed, and the losses ceased. Deaths in older pigs are not uncommon following the ingestion of hay and straw—particularly barley straw—which often plugs the pyloric opening, causing distension of the stomach and fits. One wonders why pigs as young as these suckers should eat straw. It may be owing to indigestion set up by rich milk of the mother, and lack of exercise, or it may be eaten out of pure mischief.

Deaths in Pigs from Fermented Potatoes.

Two pigs about three months old died suddenly. They were found dead in the morning, though to all appearance perfectly well when fed the night before. They were fed on potatoes—good and bad—from an allotment. The potatoes were boiled in a copper, sufficient being done to last two or three days, and they were left in the copper. The copper stood in the sun, the weather being hot at the time. There was evidence that the contents had undergone some fermentive change, for a dirty scum had settled on the top. The post-mortem examination showed gastro-enteritis and septicæmia, and I should imagine death was due to the food being loaded with bacteria rather than to vegetable poison.

Enteritis, Yellows, or Dysentery in Young Pigs.

I DO not know much about the causative organism or the pathology of the disease, but when I see pigs about a fortnight old beginning to drink liquid resting in pools and cracks about the sty floor, I can tell the owner "that he is in for trouble if he does not stop it quickly."

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Looking into a stable one day I was amused by the antics of a litter of eleven lovely pigs about a fortnight old, when one of them stopped to sample a pool of mixed urine and food slop. As I came away the owner proudly asked me what I thought of them, and I replied by pointing out the danger they were in if he did not keep them cleaner. A week later he reported trouble among them : diarrhœa, dryness of the skin, jaundice, etc. Nine died, and the remaining two were knocked on the head after nursing them for weeks.

Scrotal Hernia in the Pig.

SCROTAL hernia is common in pigs, and its radical cure does not offer much payment, if time and the usual operative technique is to be spent on it. Many operators merely open the scrotum, remove the testicle, and suture up ; others do a covered operation, placing a ligature round the sac just above the testicle. Both often fail to keep the hernia within bounds, and it soon increases. A more satisfactory operation is the following : The pig is held in the usual way, and the skin incised down to the tunica vaginalis, which is separated by blunt dissection down to the inguinal opening, taking care not to break through the sac wall, for it is often very thin. The pig is then reversed (stomach to operator) ; the testicle taken up in forceps and twisted three or four times, and held by the man holding the pig. Two strong sutures are passed through the skin, behind the twisted neck of the sac, and out again, passed through again, and firmly tied. The testicle in the sac is then cut off, and for extra safety the wound closed by interrupted suture.

Some Clinical Notes on Pig Diseases.

By Lieut.-Colonel A. F. CASTLE, F.R.C.V.S.
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Verminous Gastritis in Sows.

THE following notes on an outbreak of verminous gastritis may be of interest, as this condition would appear to rarely occasion deaths amongst swine as far as this district is concerned. The outbreak occurred on a farm in this neighbourhood, where large numbers of pigs had been reared for a long period, and had never previously been the cause of mortality amongst the swine. The animals affected were young sows after their first litters, and the owner's attention was first drawn to the animals as a result of the sows' loss of milk, and inability to feed their pigs after a period of four or five weeks' lactation. The young pigs did not succumb, but had to be fed artificially, and gradually lost condition, and became stunted and unthrifty.

Symptoms.—Loss of milk, wasting, variable appetite, diarrhœa, inclination to remain recumbent, marked emaciation, inco-ordination, weakness, and inability to rise. It would appear that these parasites only cause inconvenience after the natural protective mechanism of the animal has been much lowered, as in these

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cases by the heavy depletion of the system during lactation, as the parasites may be found in apparently healthy animals without causing any ill-effects.

Lesions.—The lesions consisted of diphtheresis, corrugation and thickening of the mucous membrane of the stomach ; the whole of the lining of the stomach being covered with a yellow-tinted gelatinous deposit in which numerous parasites were present. The bowels showed areas of congestion.

Course of Disease.—The course of the disease is chronic, lasting four to five weeks. The mortality is high, but recovery in a small percentage of cases does take place.

In the outbreak to which I have referred, three sows died as a result of the disease, but eight were killed owing to the extreme debilitated and emaciated condition to which they were reduced. Causal parasite—*Hyostrongylus rubidus* ; male, 6 to 8 mm. ; female, 10 to 11 mm. The parasites can be detected with the naked eye, but their presence is markedly assisted by the aid of a magnifying glass.

Endocarditis in Swine.

This lesion frequently follows subacute or chronic types of swine erysipelas, and is often the cause of sudden death in animals which have some time previously apparently entirely recovered from an attack of this disease. In some animals, however, a train of symptoms, as a result of the cardiac lesion, is encountered, and includes accelerated respirations, endocardiac murmurs, which are readily detected with the stethoscope, inability to walk, or manifestation of fatigue on slight exertion ; some enlargement in the region of the articulations of either fore or hind limbs. The valves on either side of the heart may be affected, but in our experience the left side of the heart is more commonly the seat of the lesion, which may vary from a marked discoloration of the auricular-ventricular valves, to the formation of luxuriant verrucose vegetations in this position. It is doubtful whether verrucose carditis occurs in the pig, except as a result of swine erysipelas infection, but in other animals this disease has been recorded quite unassociated with erysipelas.

Cirrhosis of the Liver in Swine.

This disease may be found to affect swine of any age, and is frequently encountered in pigs about eight to ten weeks of age shortly after they have been weaned, and is often the cause of fatal illness. Several animals of the same litter may be affected, and it would therefore appear to be due to some common factor, such as error in feeding too stimulating a diet. This condition would also appear to be frequently associated with degenerative changes in the walls of the large blood vessels, as often on post-mortem, where an animal is found to have died as a result of internal hæmorrhage in connection with some of the large visceral blood vessels, cirrhosis of the liver is also present, and would appear to be the primary factor. On post-mortem, the liver is usually found much enlarged, and the consistence greatly increased, being harder and firmer than normal, as a result of the increased interlobular tissue present. In the later stages of the disease

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the organ is usually shrunken and diminished in volume, but markedly increased in density.

Symptoms.—The usual history is that the animal has been noted to be unthrifty for a period, and has been affected with diarrhœa. Loss of condition and slight icteric staining of the visible mucous membrane is usually present.

Treatment is seldom successful, but beneficial results in young pigs frequently follow free range on grass and curtailment of the protein ration. Bran should also be fed in liberal quantity, with middlings, and all stimulating diet avoided for a period.

Serum Treatment of Swine Erysipelas.

It is recognised that three types of this disease may be encountered—acute, subacute, and chronic—and that outbreaks vary considerably in virulence. In the acute type one or more pigs, usually in prime condition, may be found dead without having shown any premonitory symptoms, but this disease may occasionally be found affecting suckling pigs. In the subacute or urticarial type, the animal has usually been noted to isolate itself from the other pigs in the yard, refuse food, and manifest the usual symptoms of high fever, as a temperature of anything up to 110° may be present, and the usual skin lesions in evidence. In the chronic type, lameness, as a result of arthritis and synovitis, affecting the carpal, tarsal, metacarpo-phalangeal or metatarso-phalangeal articulations, with enlargements of these joints, is usually present.

Symptoms associated with cardiac incompetence are frequently encountered. Practitioners who are required to make post-mortem examinations on pigs will be well advised to habitually wear rubber gloves whilst conducting post-mortem examinations, and also ensure their thorough sterilisation after dealing with swine erysipelas cases. In two instances in my experience assistants at post-mortem examinations of pigs suffering from this disease have contracted the disease, although in one case gloves were worn by the victim concerned. In this case, however, I was able to establish that the gloves had been unwittingly turned outside-in, after infection at a previous post-mortem. Both these cases recovered after treatment with large doses of erysipelas serum at the local hospital.

Treatment.—Treatment of a large number of outbreaks of this disease in pigs over a considerable period has resulted in the following : In the acute and sub-acute types of the disease, 80 to 92 per cent. of recoveries have followed the injection of serum. In the treatment of all outbreaks of swine erysipelas we have, as routine treatment, injected all the affected and in-contact pigs with serum. The former have usually received double doses, 100 c.c., depending on size and age of the animal, and the latter up to 50 c.c. It may be considered that the serum has been used in excessive quantities, but it is recognised that this procedure is attended with better results, and is more economic than when a second visit and re-inoculation of the affected animals is necessary. In the vast majority of outbreaks dealt with, when the doses of serum indicated above are administered, no second visit is necessary.

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